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Maeda

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(54) **THROWAWAY INSERT**

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B23B 27/20 (2006.01)

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B23B 2200/085; B23B 2200/245;
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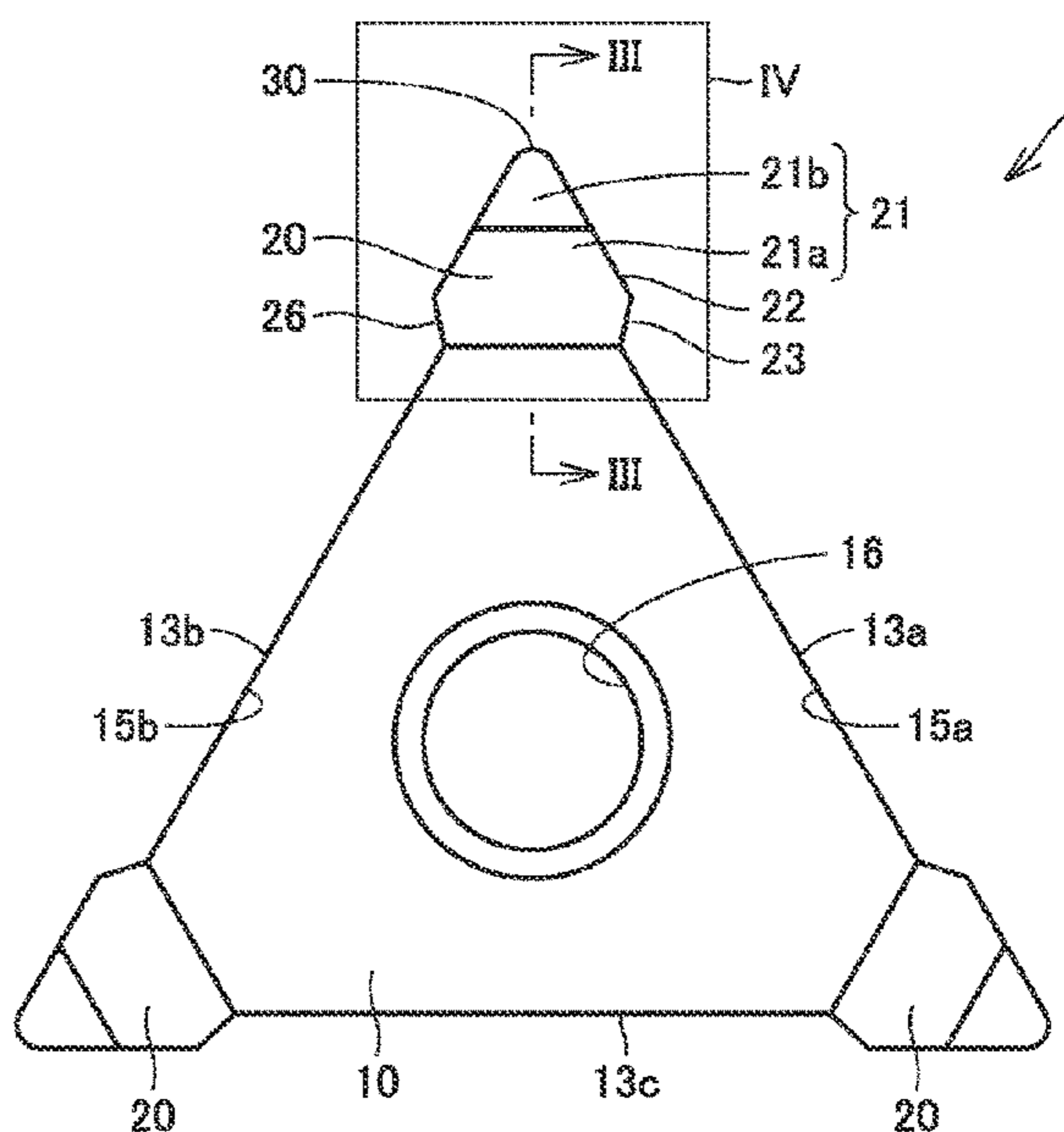
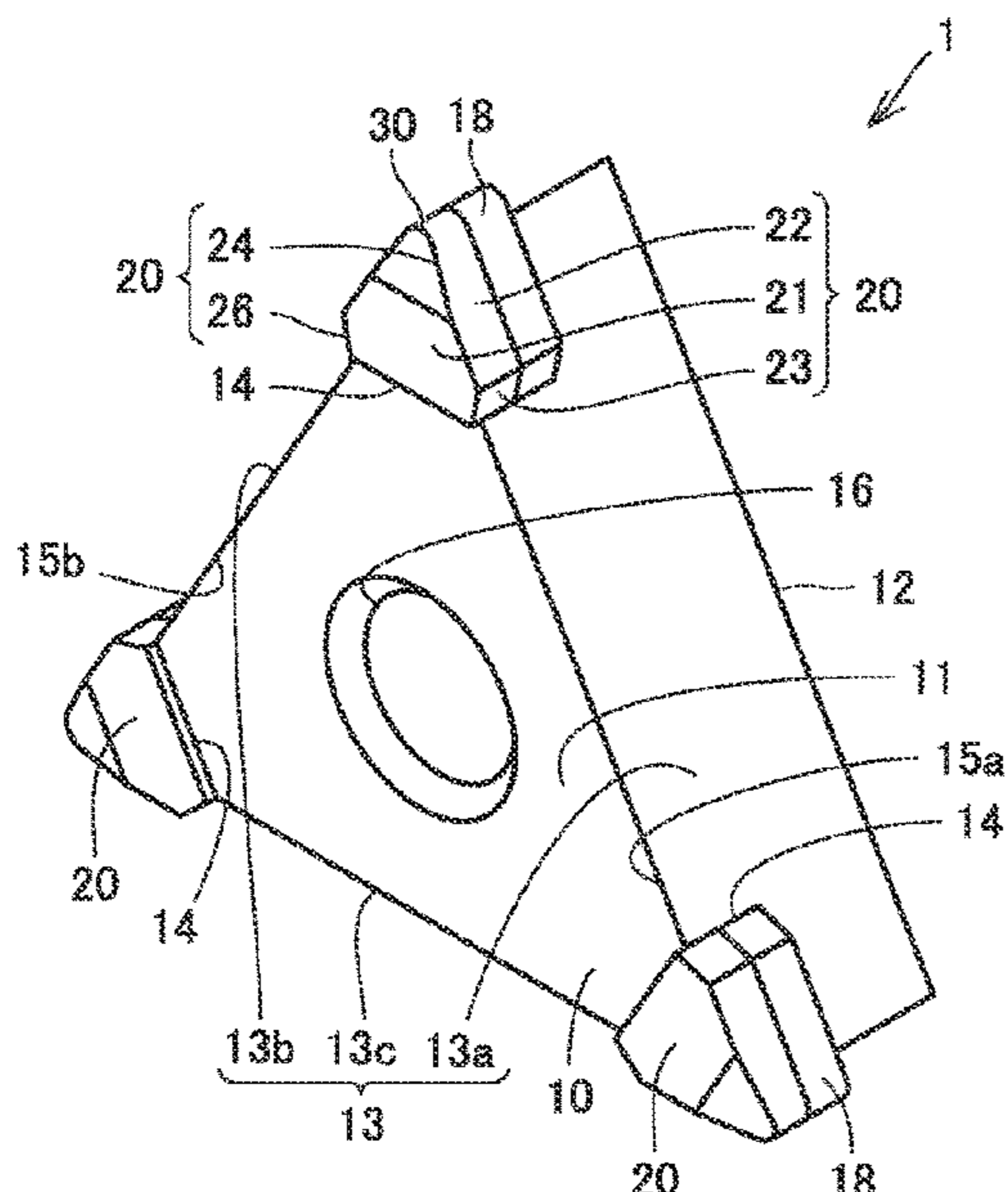
Primary Examiner — Sara Addisu

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Michael A. Sartori

(57) **ABSTRACT**

The throwaway insert includes a base and a cutting edge member. The cutting edge member includes a rake face, a flank face, a first connecting face, a second connecting face, and a first ridgeline serving as a cutting edge. The rake face includes a main surface and a first chamfer provided at an edge tip portion of the cutting edge member, the edge tip portion including an extreme tip portion of the cutting edge member. In a plan view from an upper surface of the base, the flank face, the first connecting face, and the second connecting face are located external to the base. The first chamfer is inclined relative to the main surface so as to increase a thickness of the cutting edge member as the first chamfer is closer to the main surface.

12 Claims, 13 Drawing Sheets



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 (2013.01); *B23B 2200/242* (2013.01)

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2226/315; *B23B 27/20*; *B23B 2226/125*;
B23B 2226/18; *B23B 2200/083*; *B23B*
2200/201; *B23B 2200/242*

See application file for complete search history.

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FIG. 1

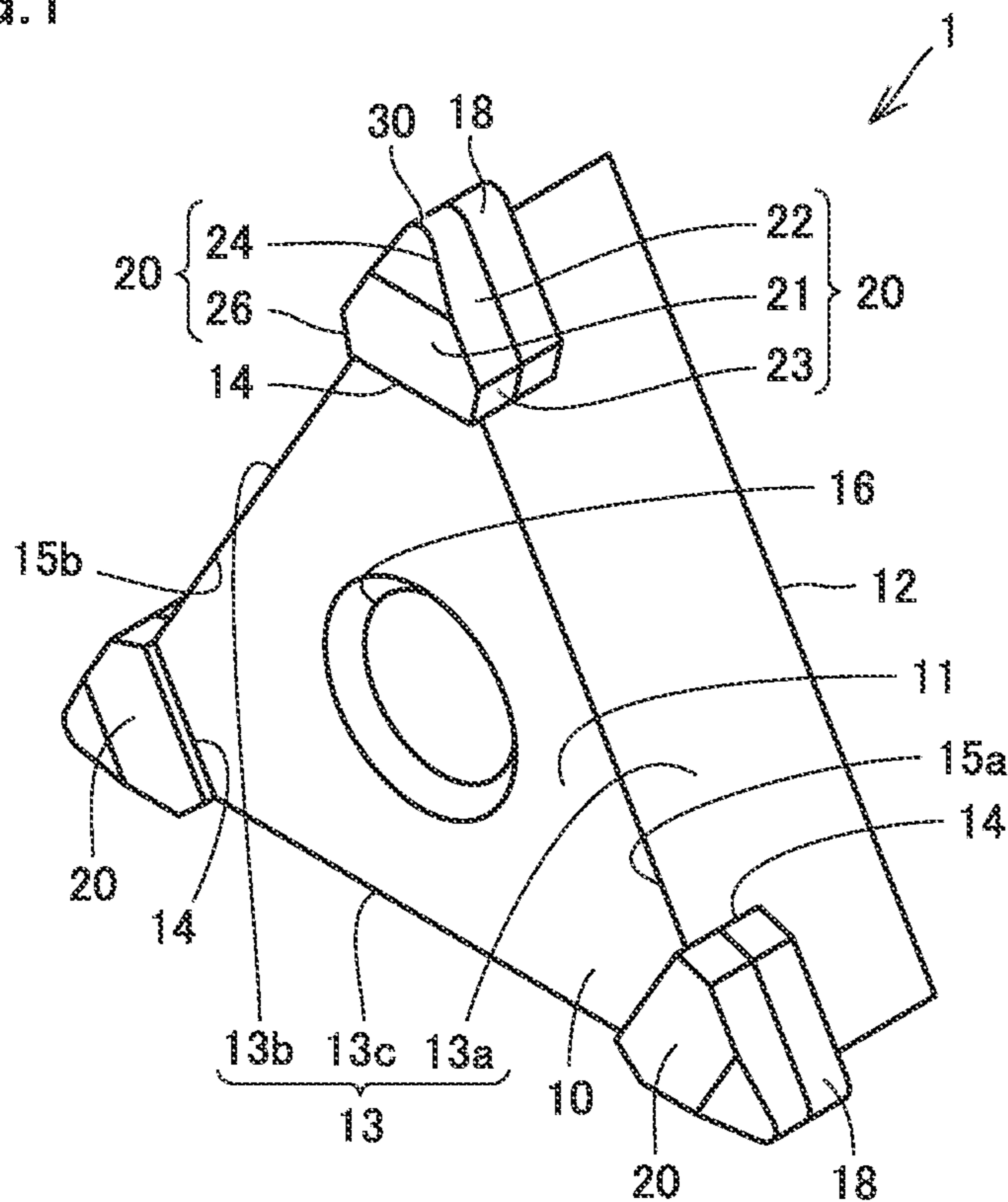


FIG. 2

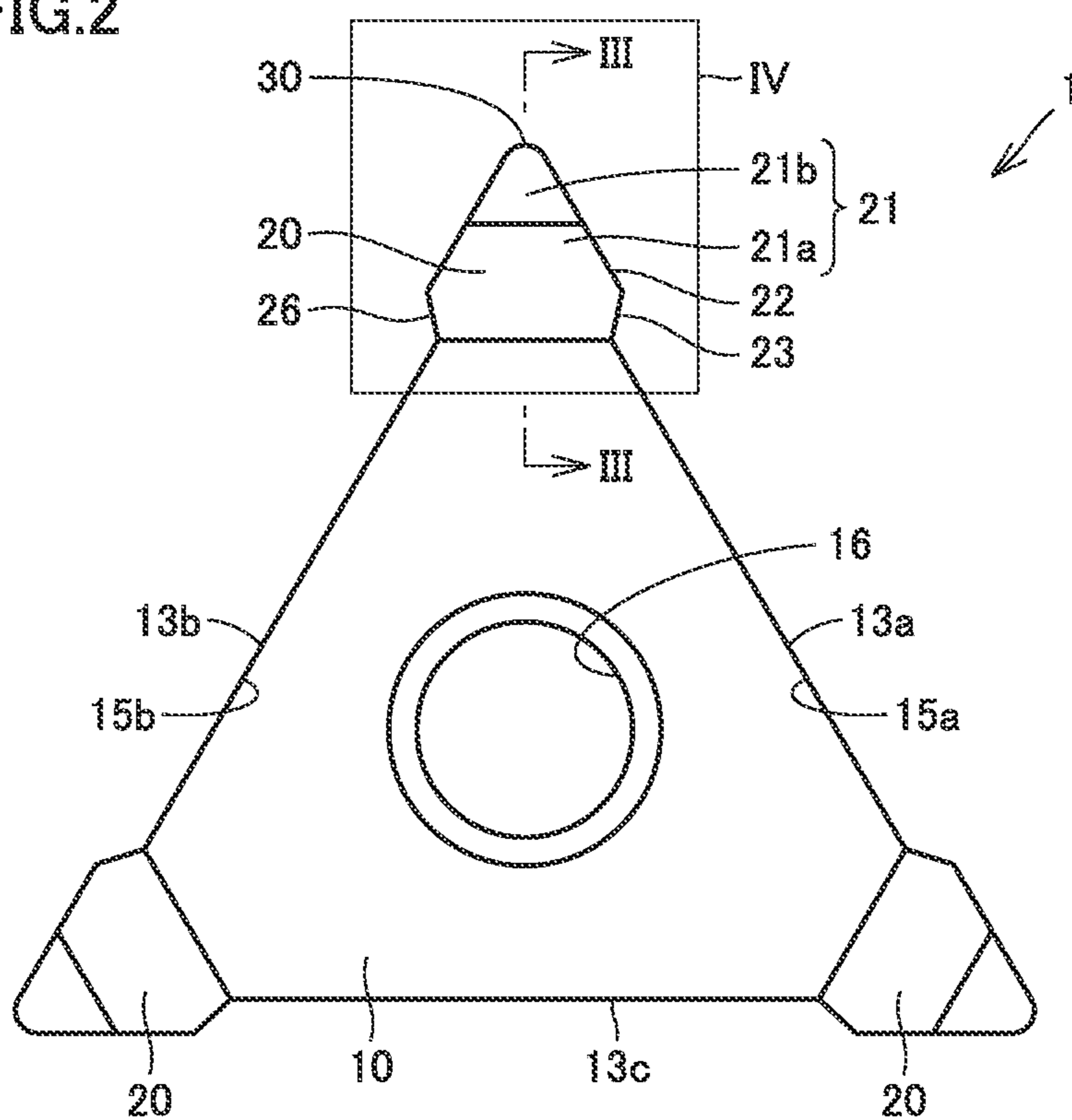


FIG. 3

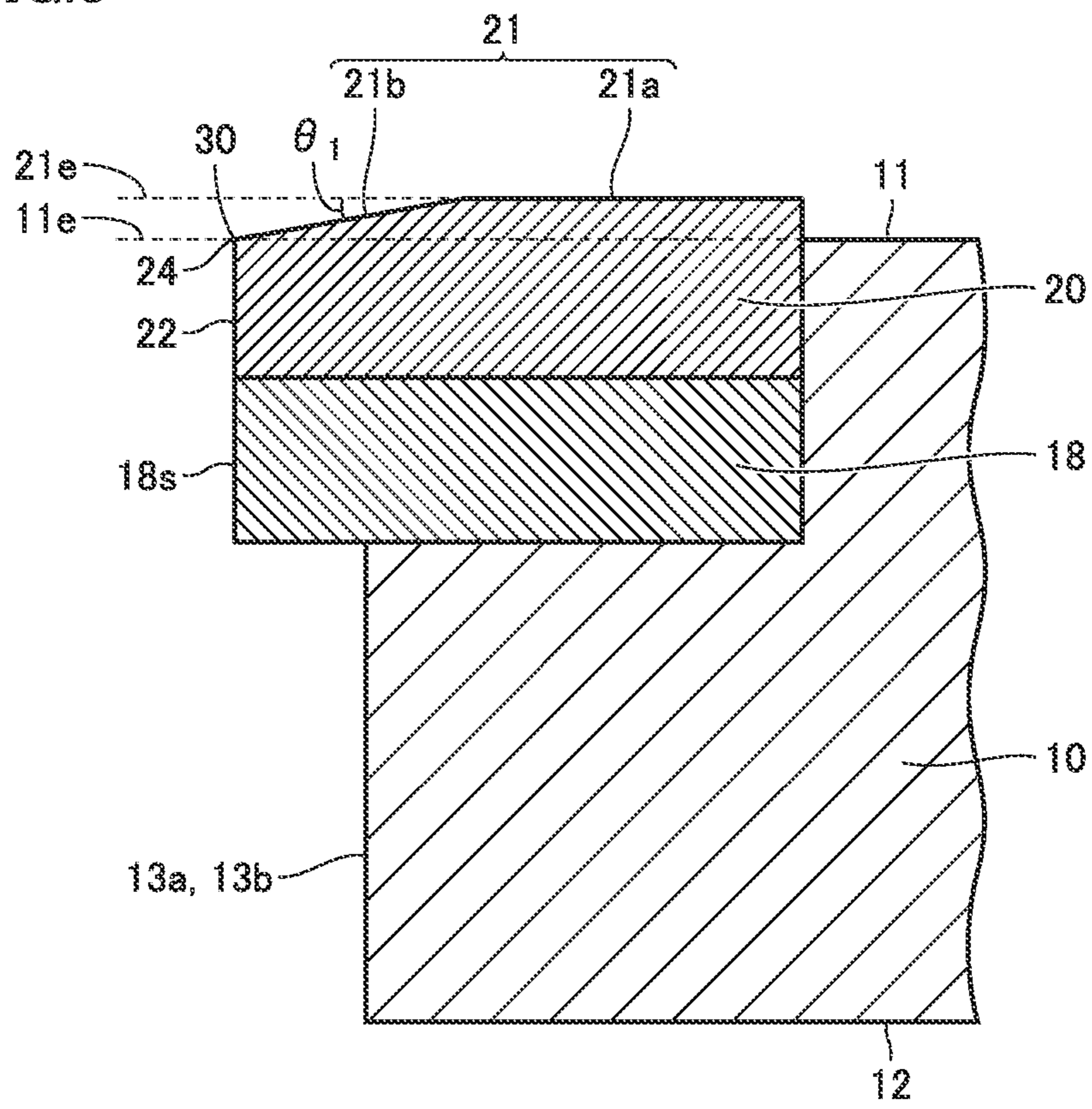


FIG. 4

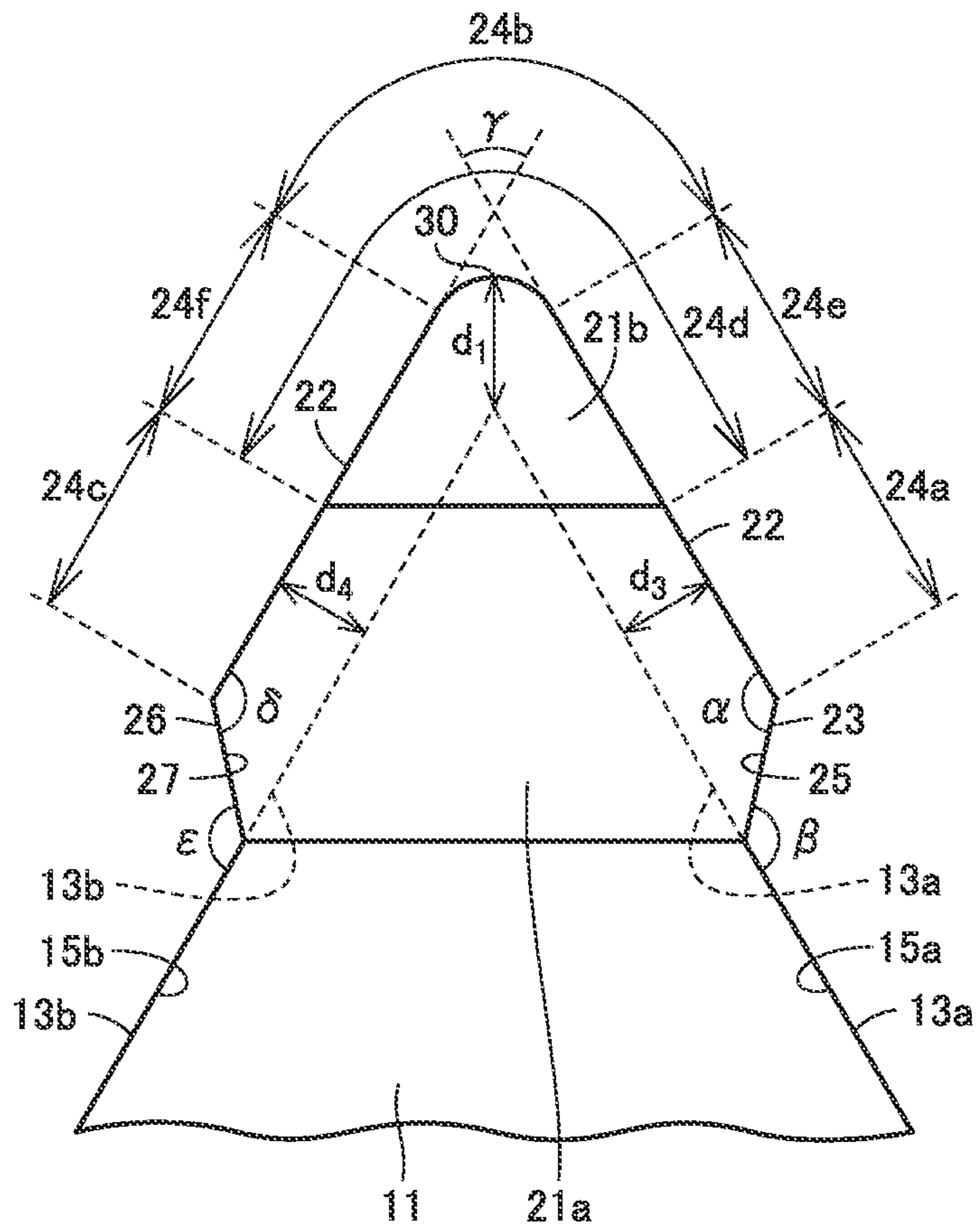


FIG.5

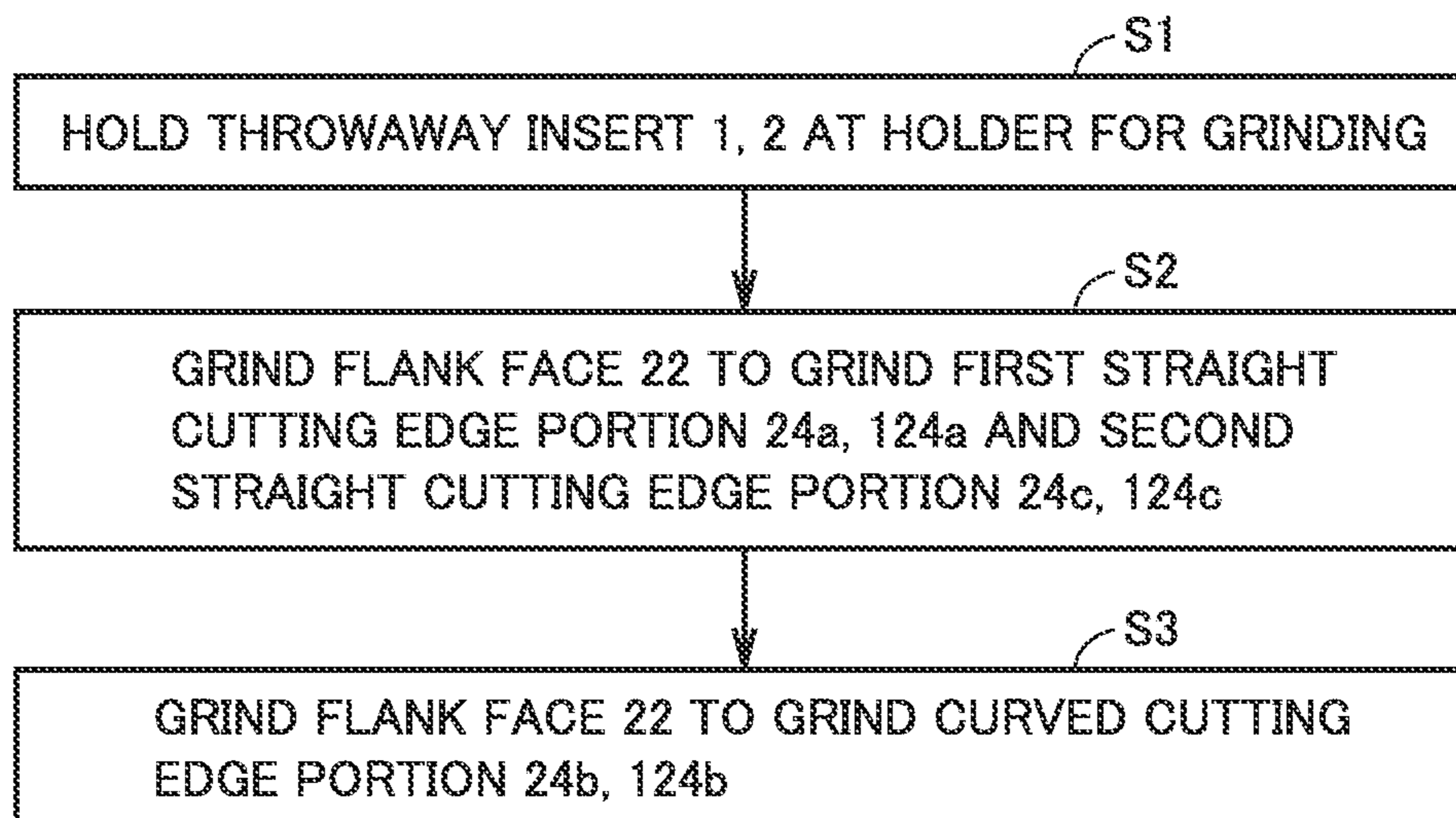


FIG.6

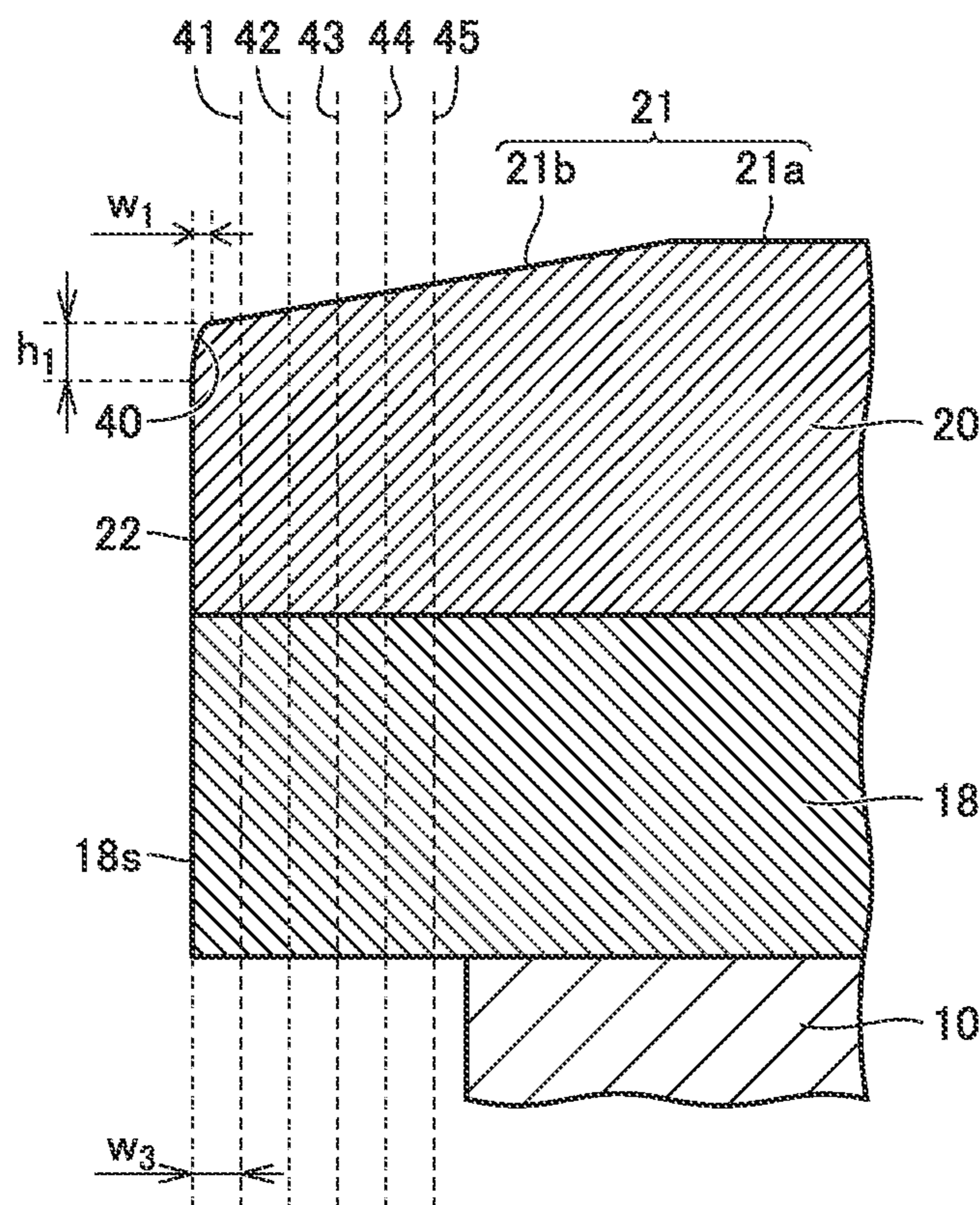


FIG. 7

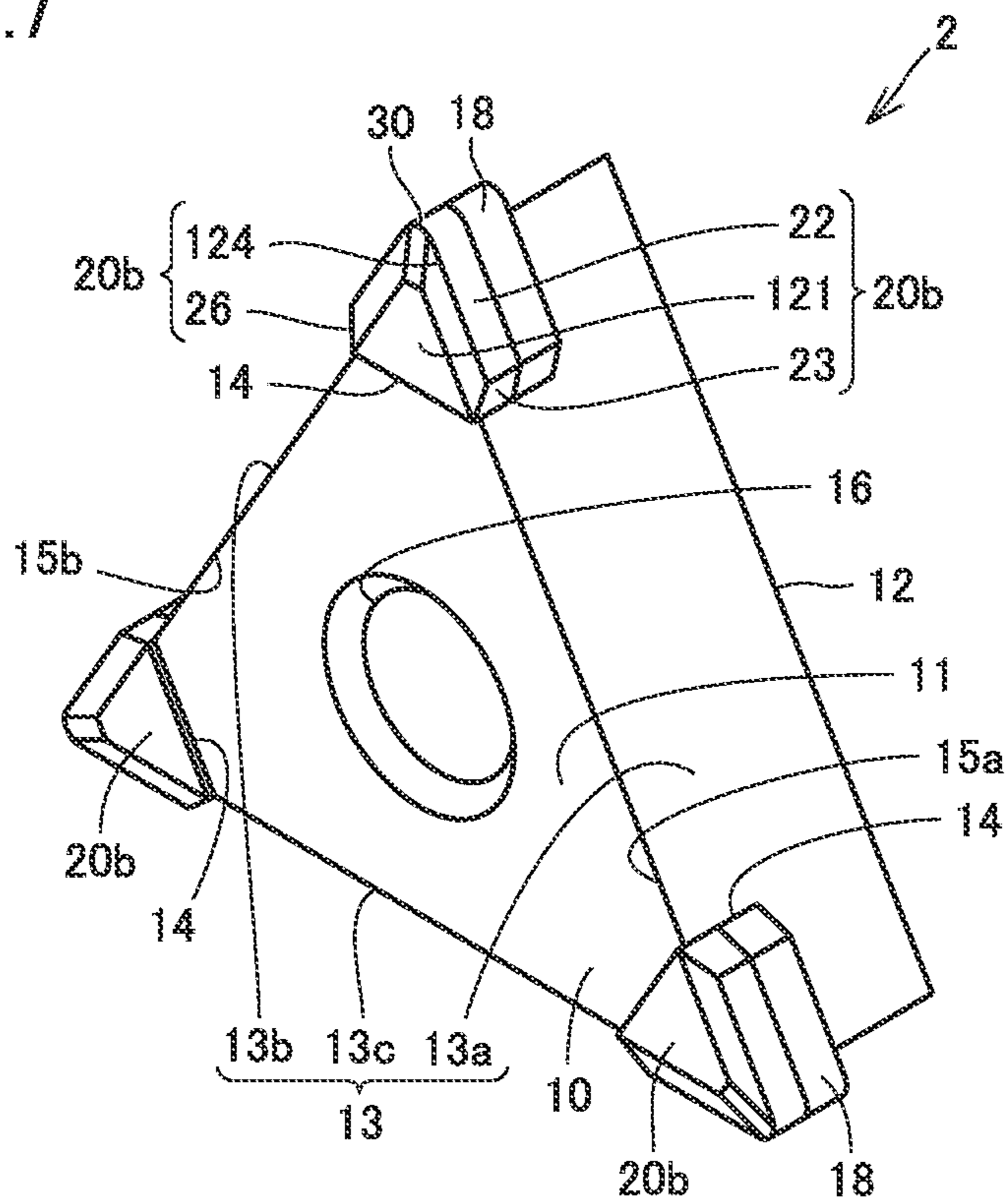


FIG. 8

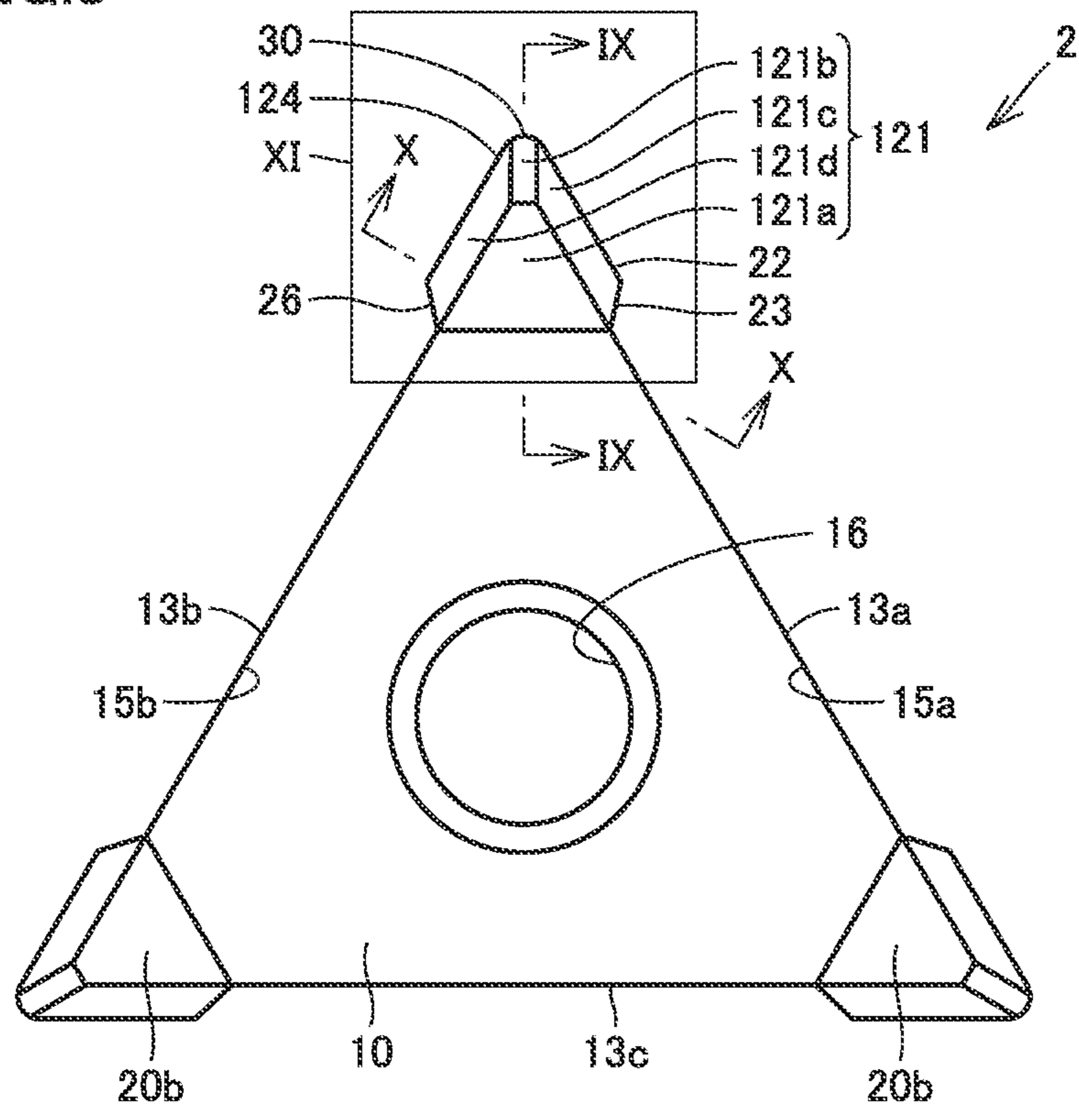


FIG.9

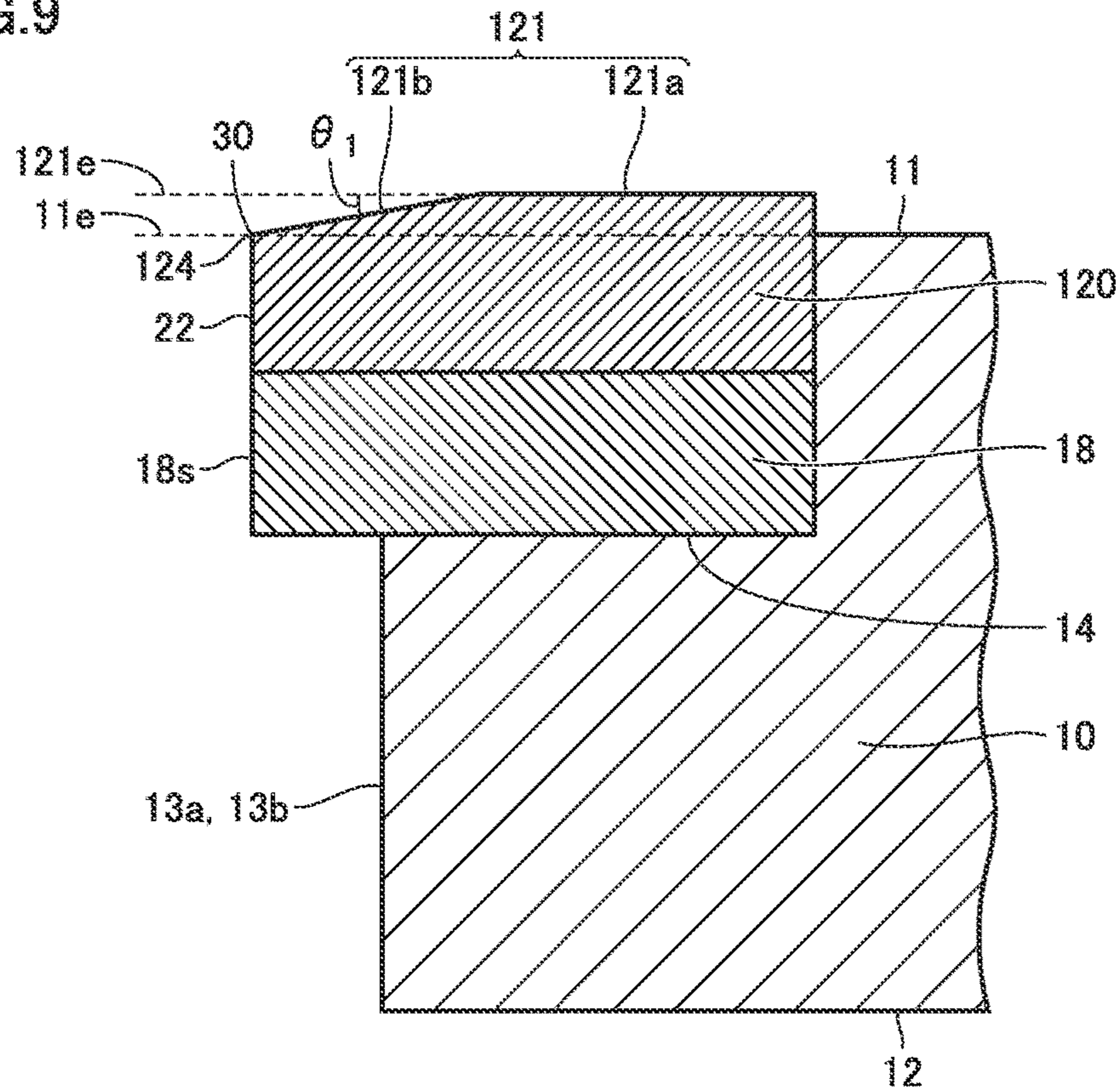


FIG.10

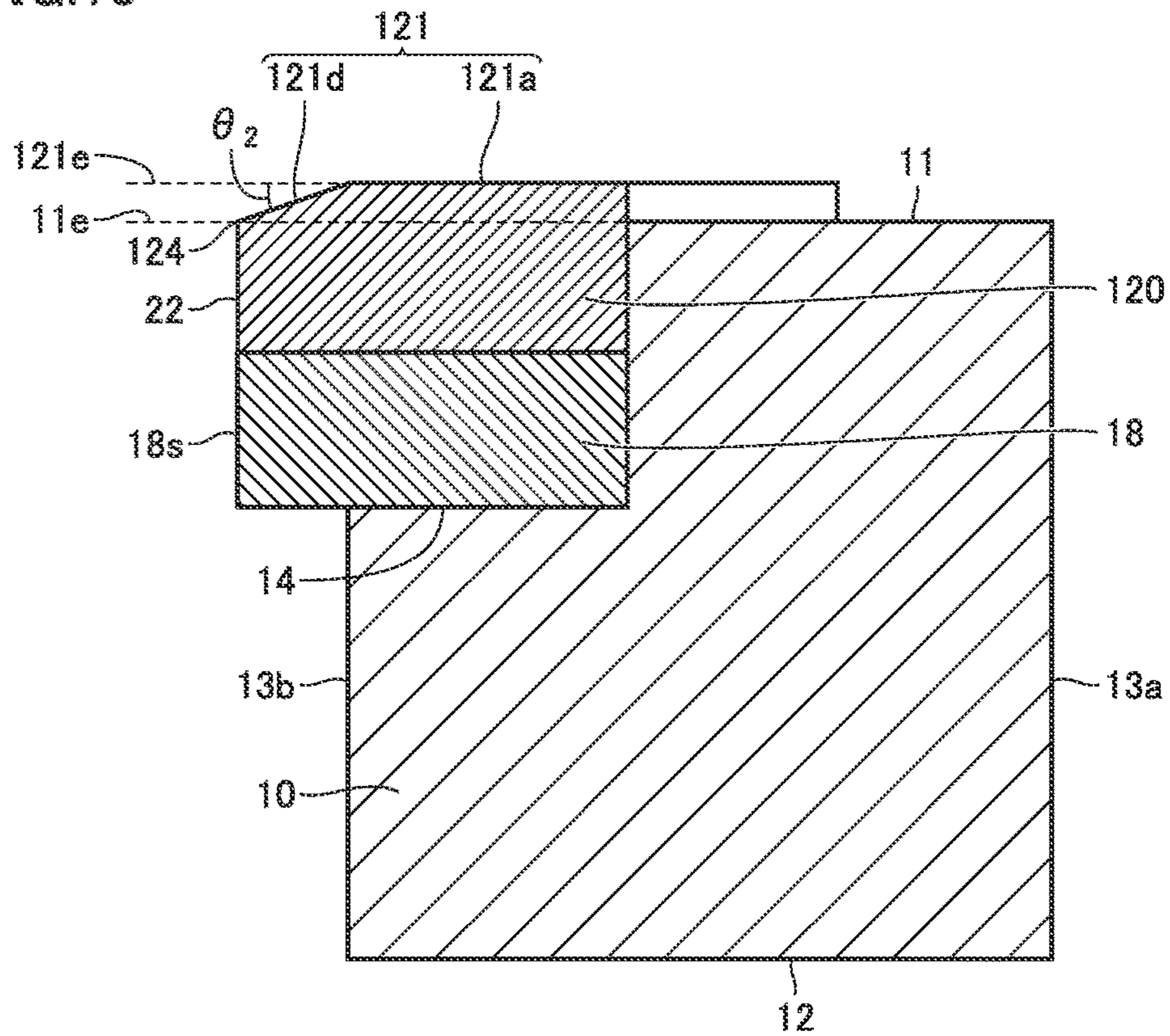


FIG. 11

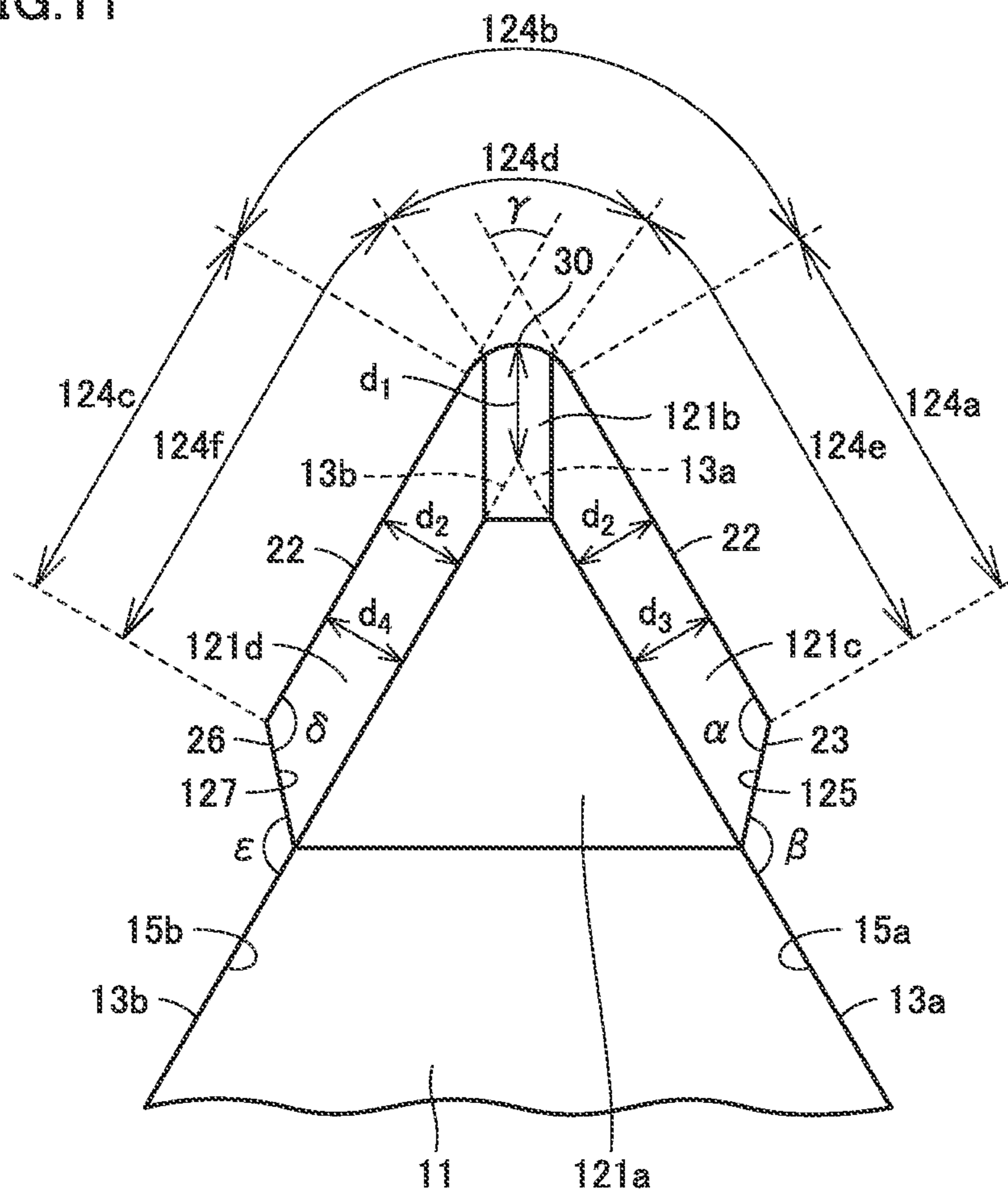


FIG.12

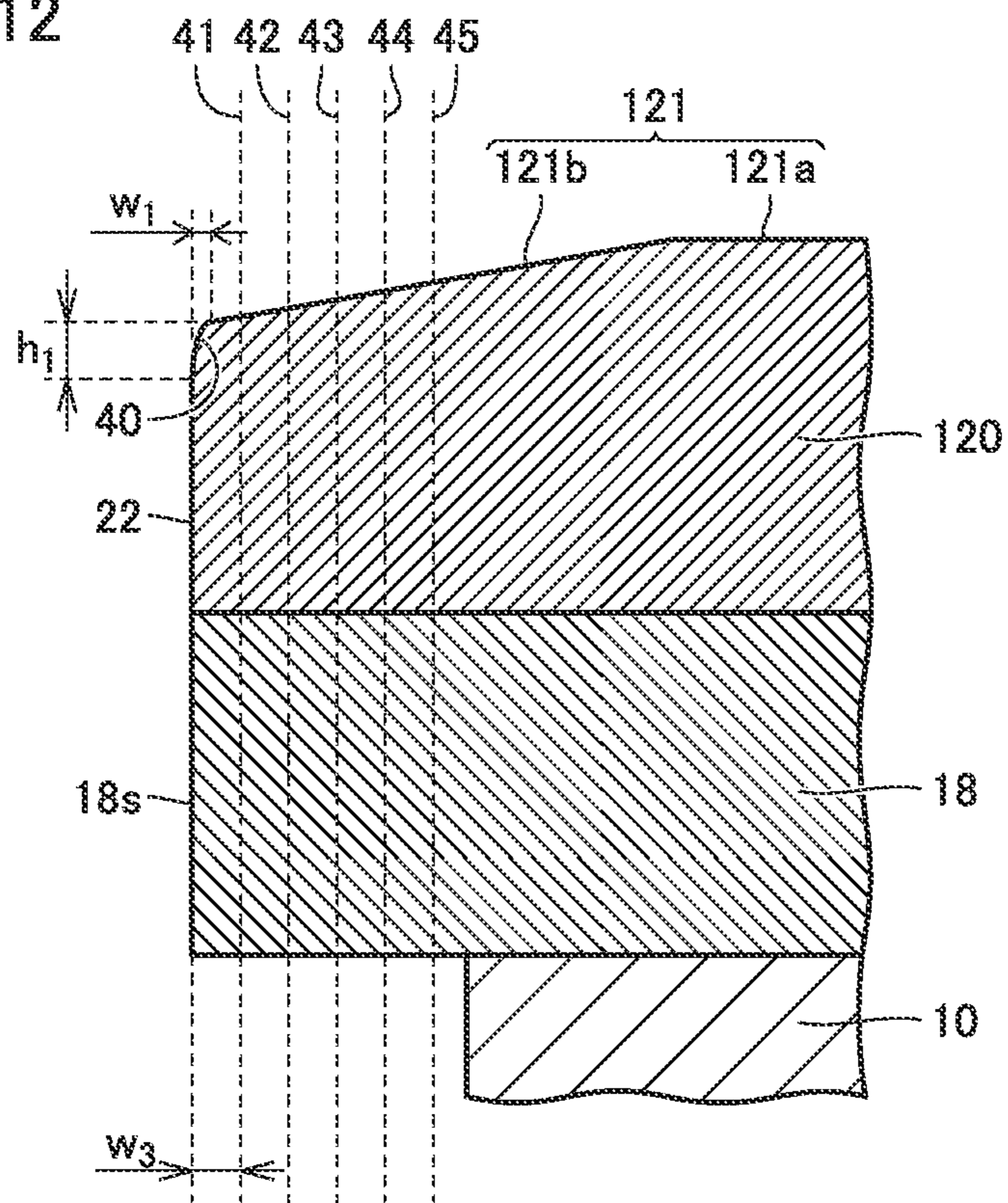


FIG.13

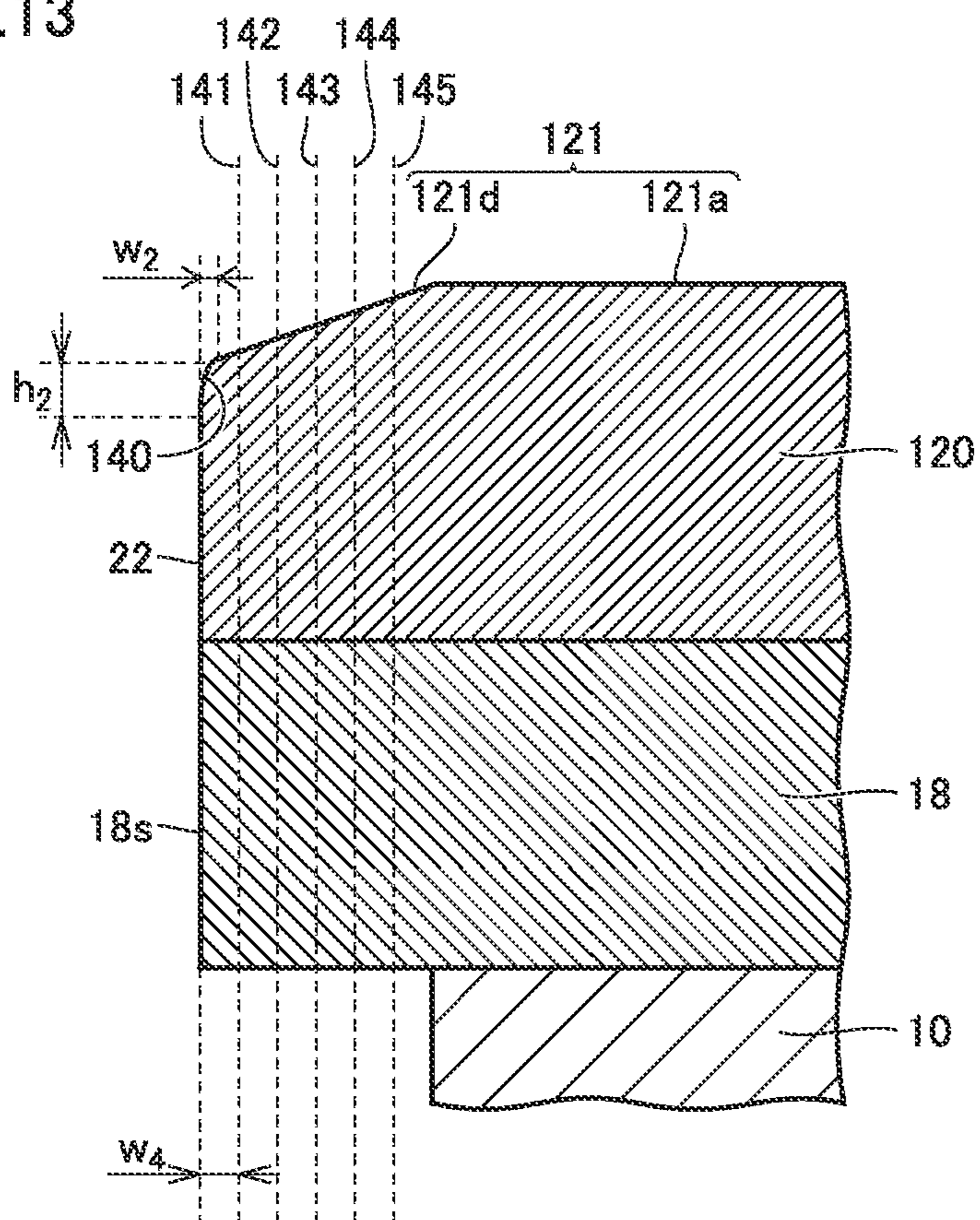


FIG. 14

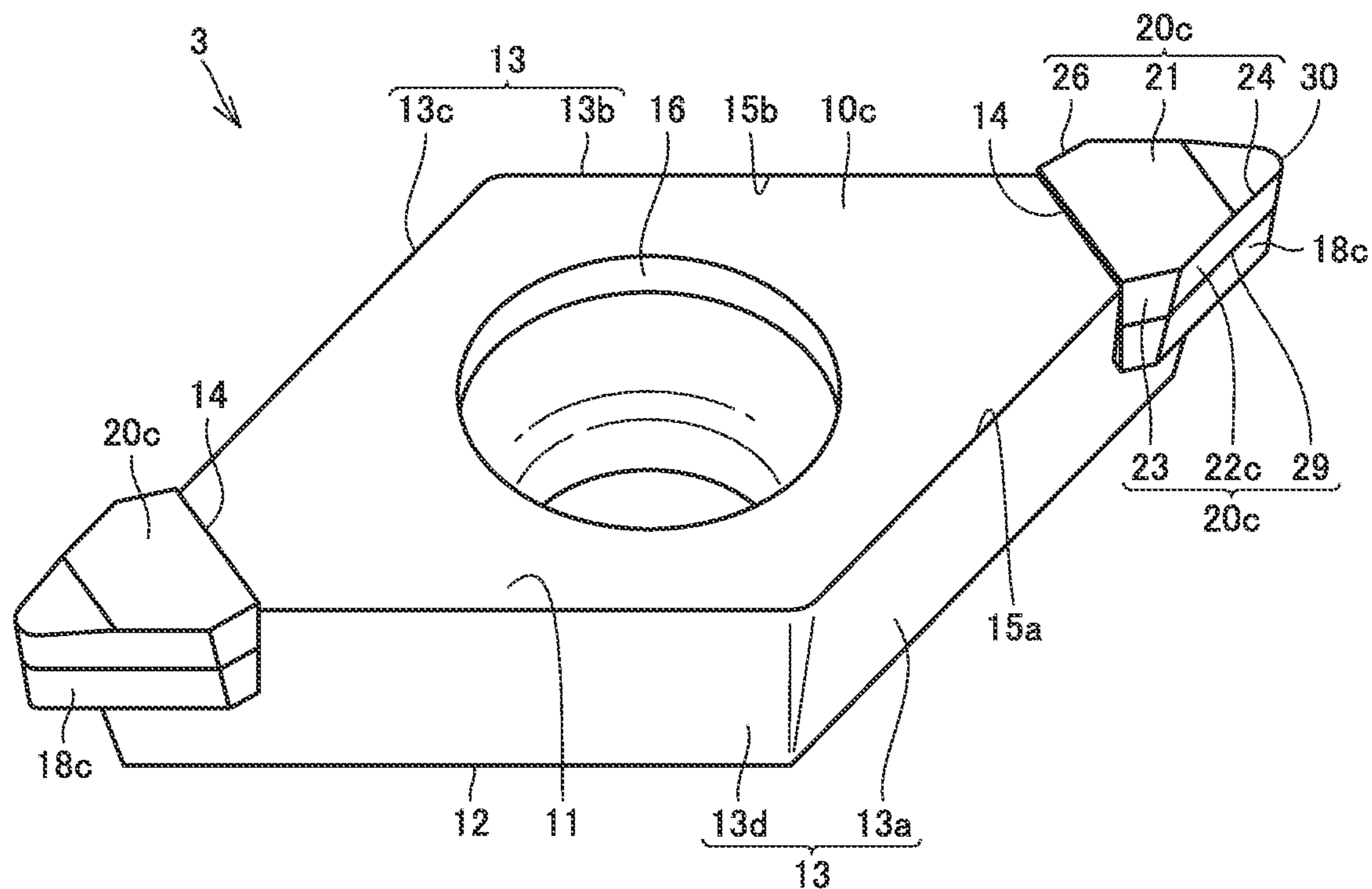


FIG. 15

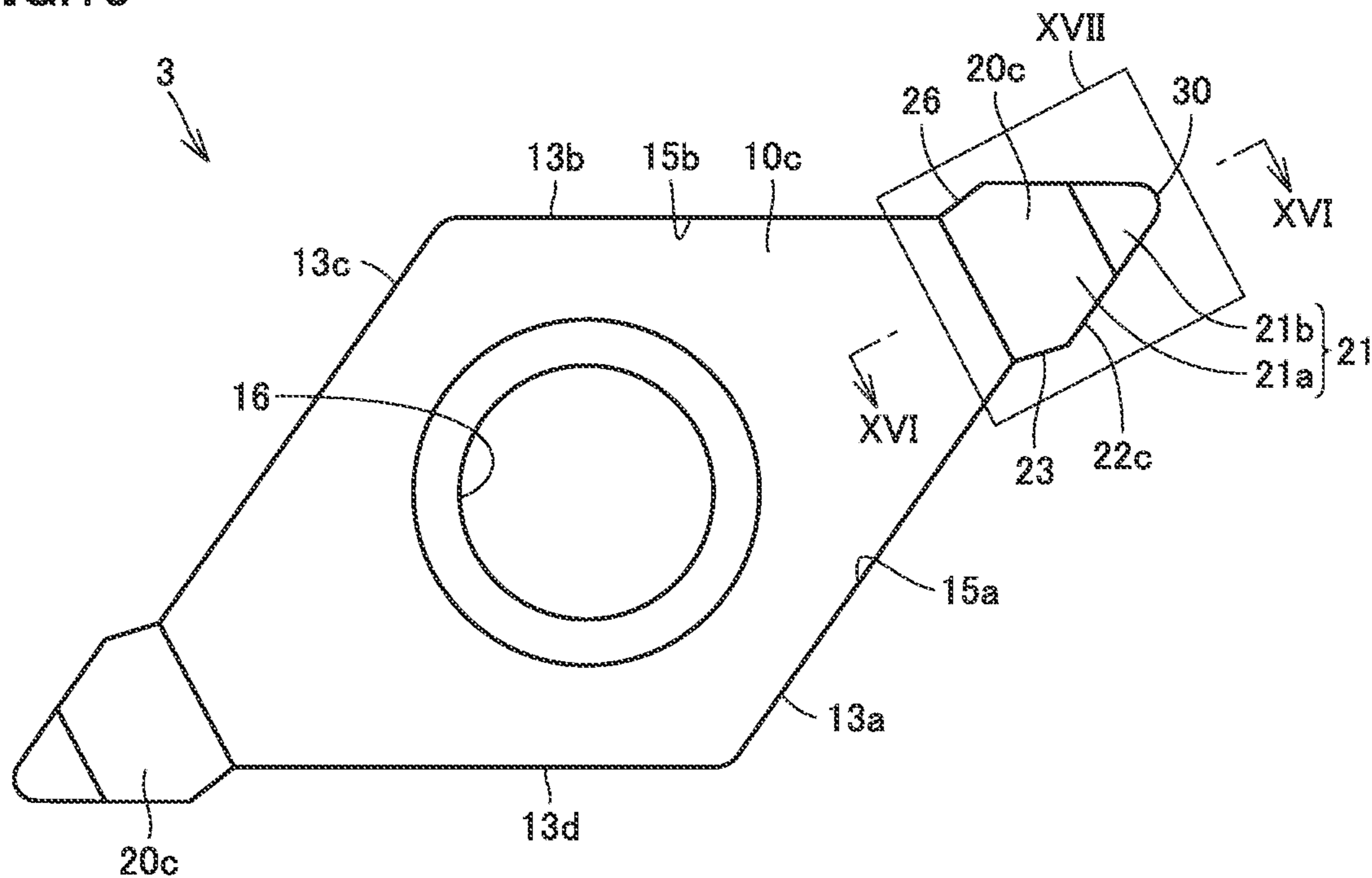


FIG.16

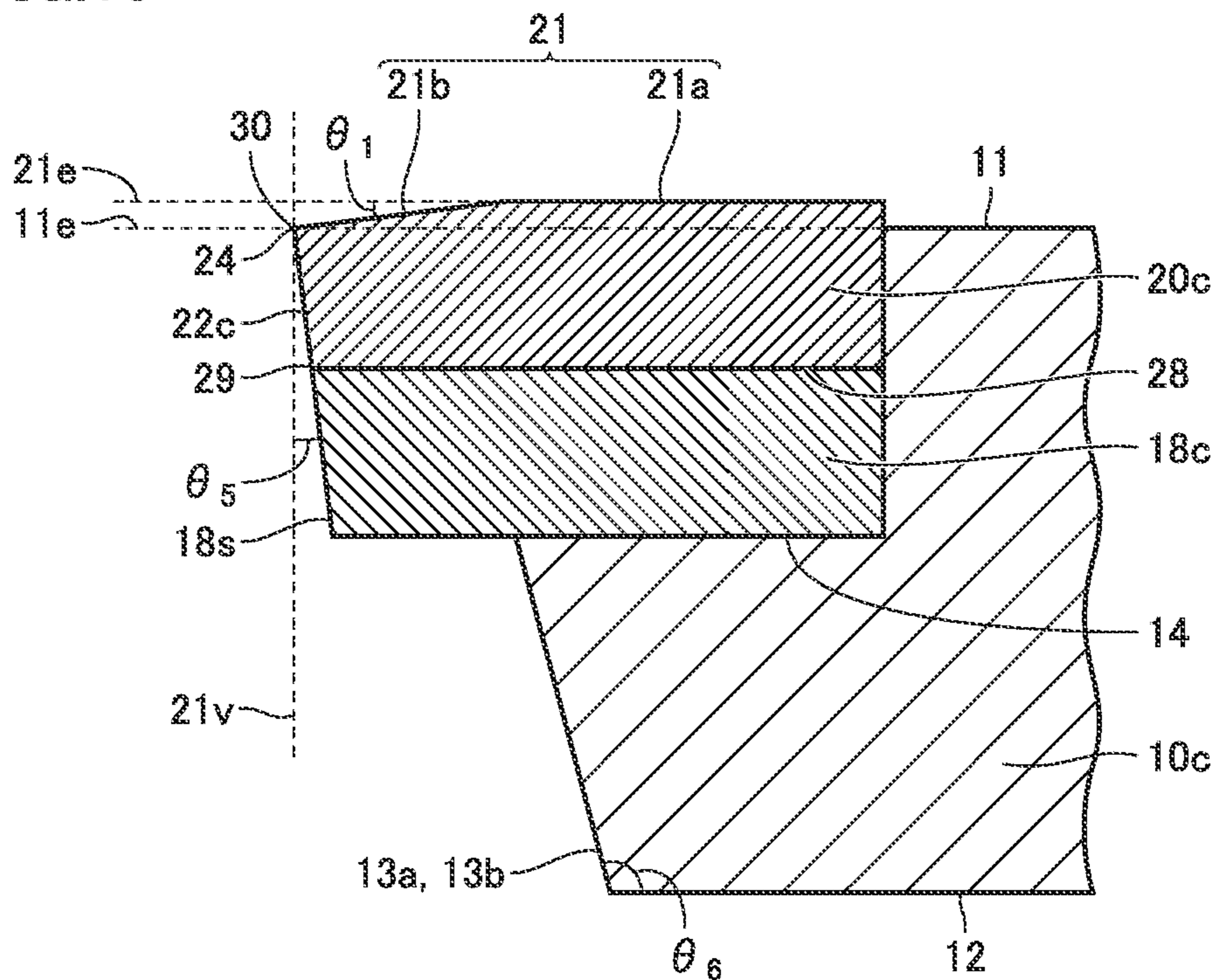


FIG.17

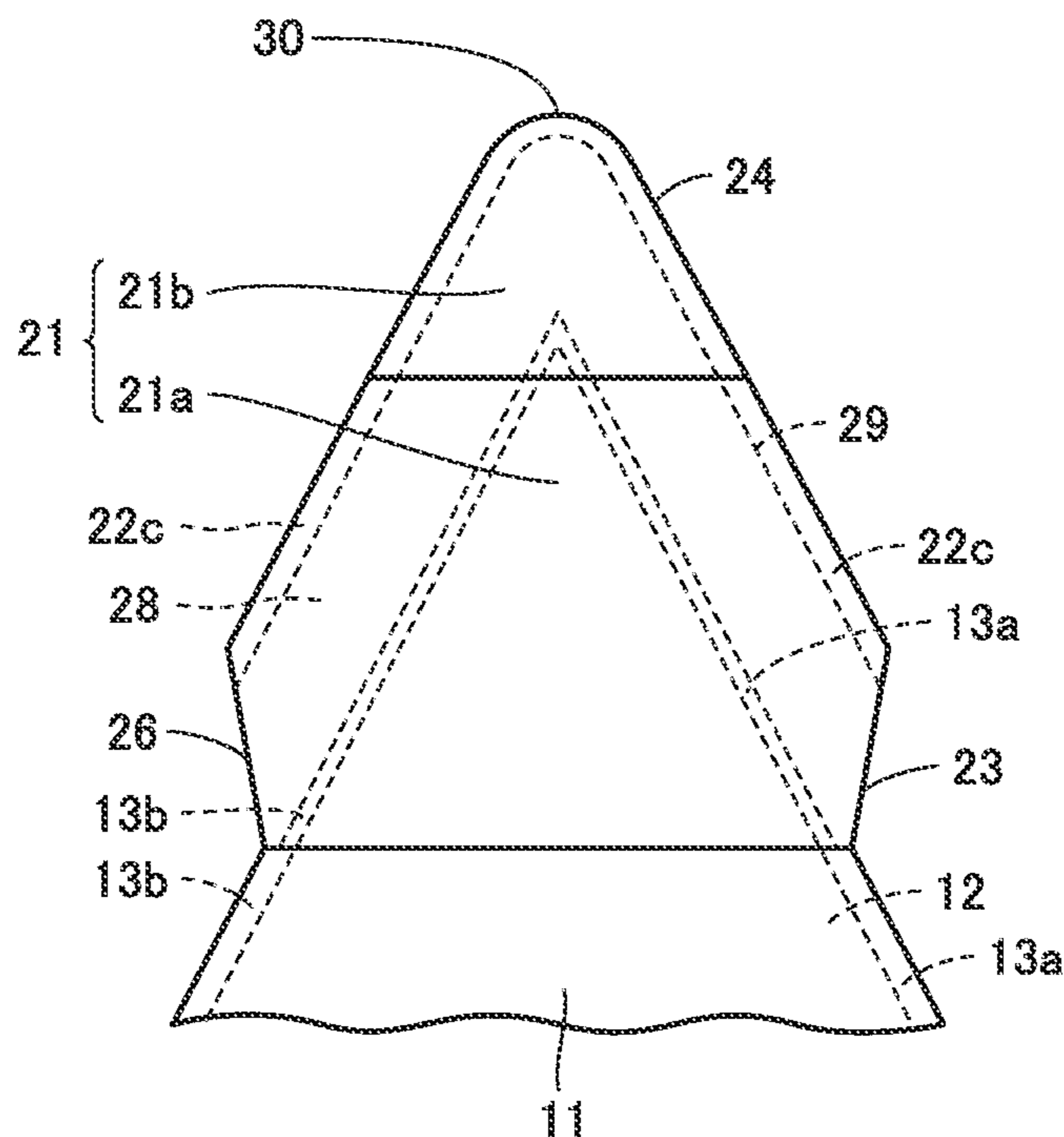


FIG.18

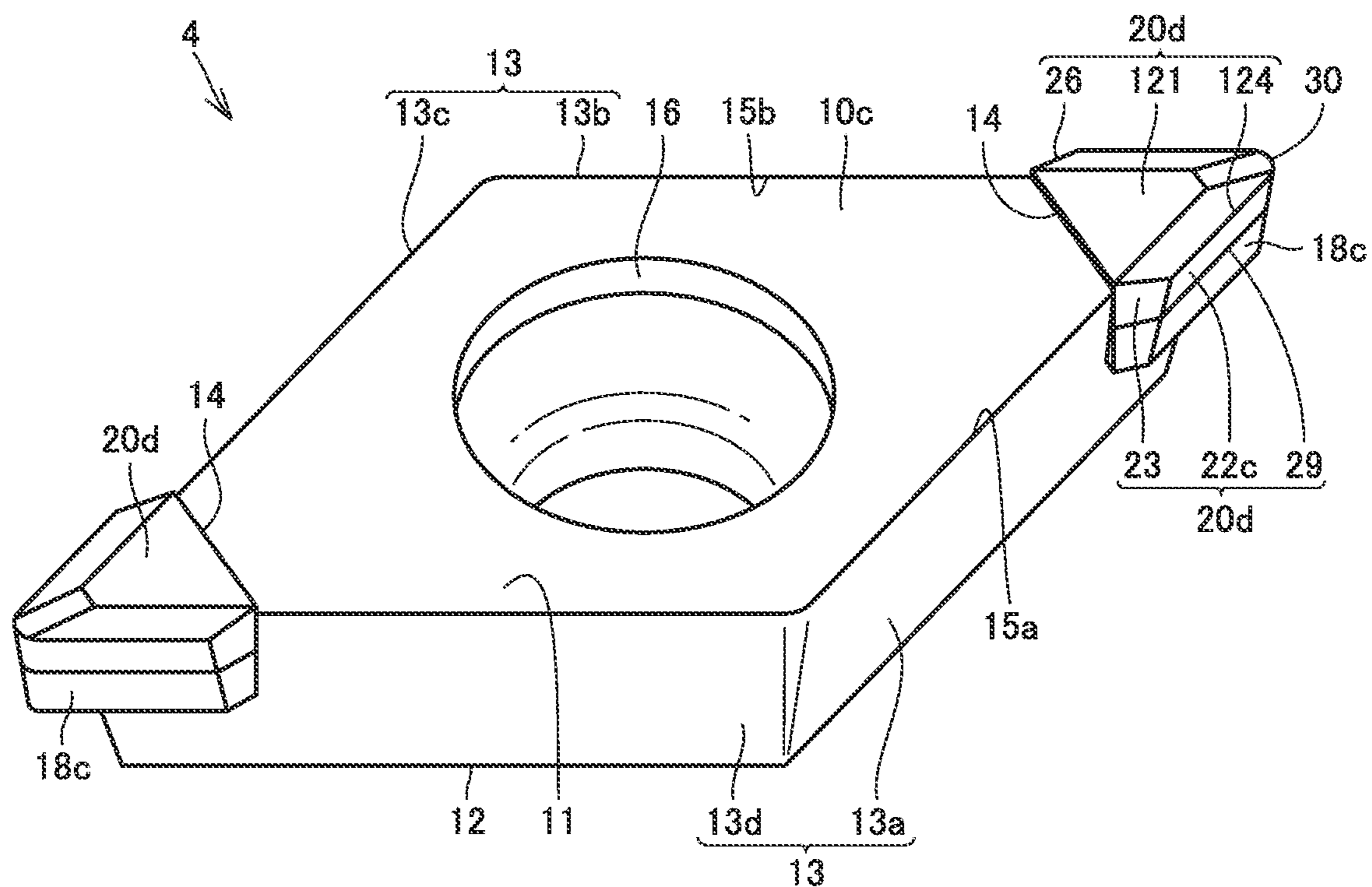


FIG.19

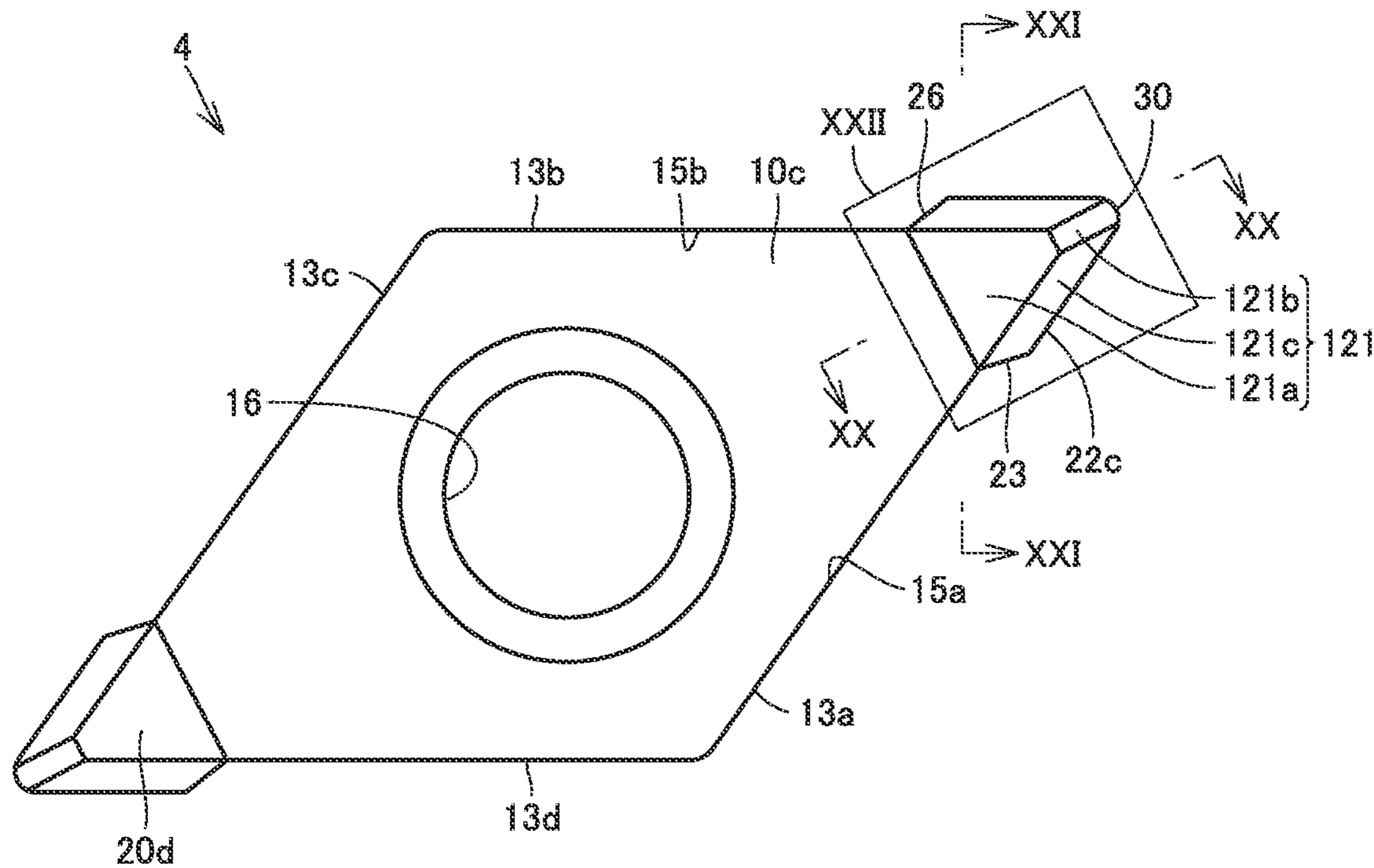


FIG.20

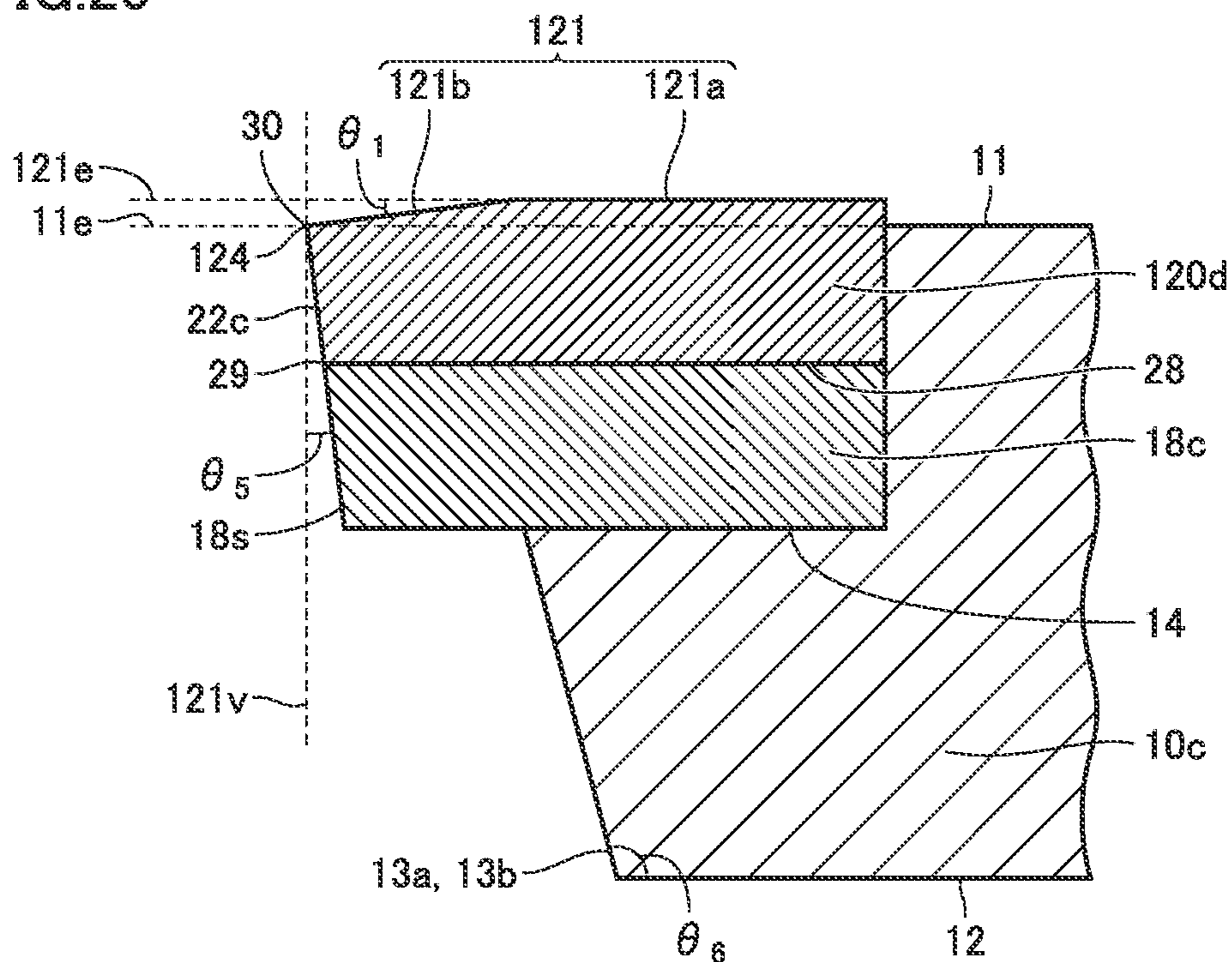


FIG.21

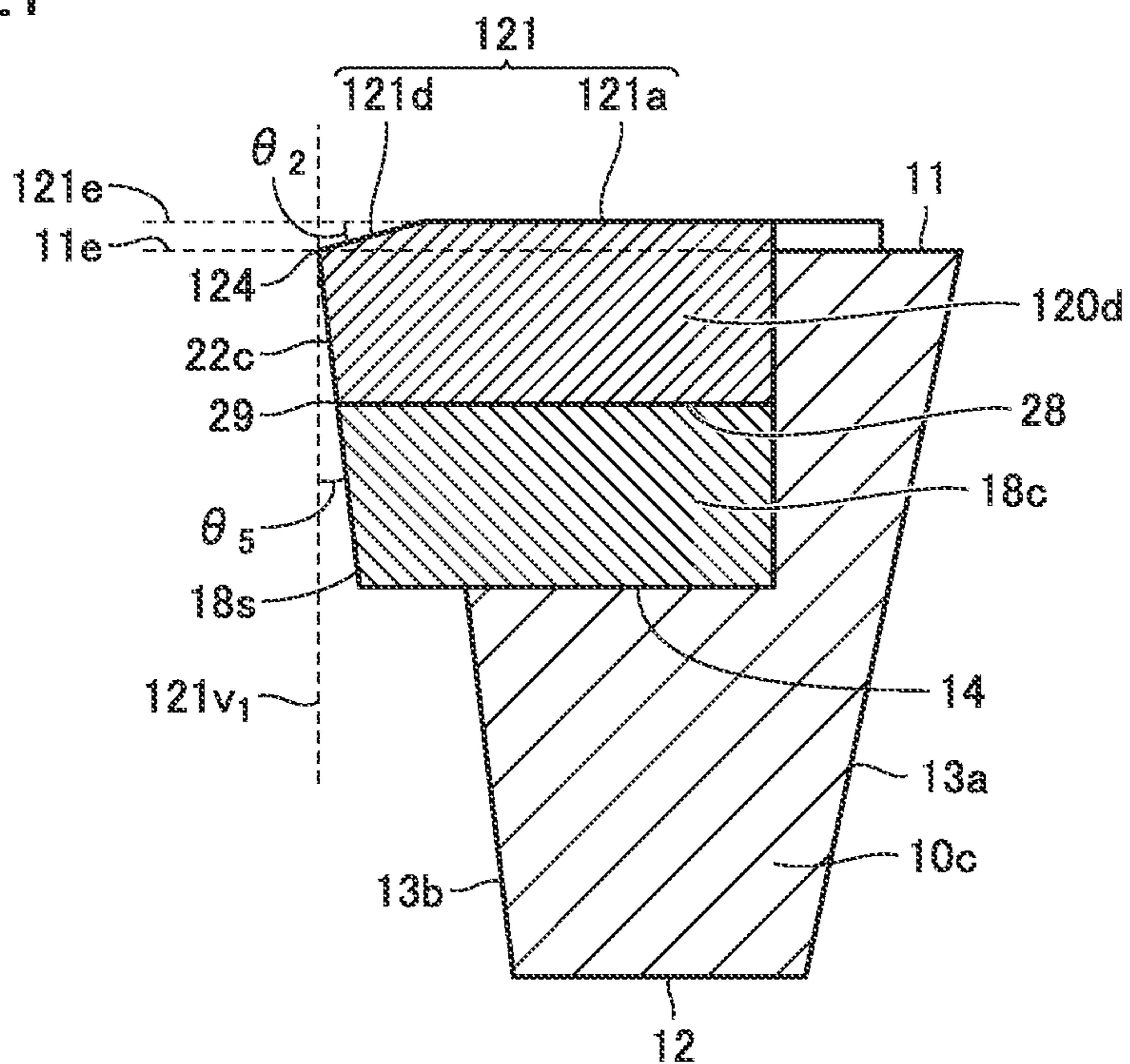
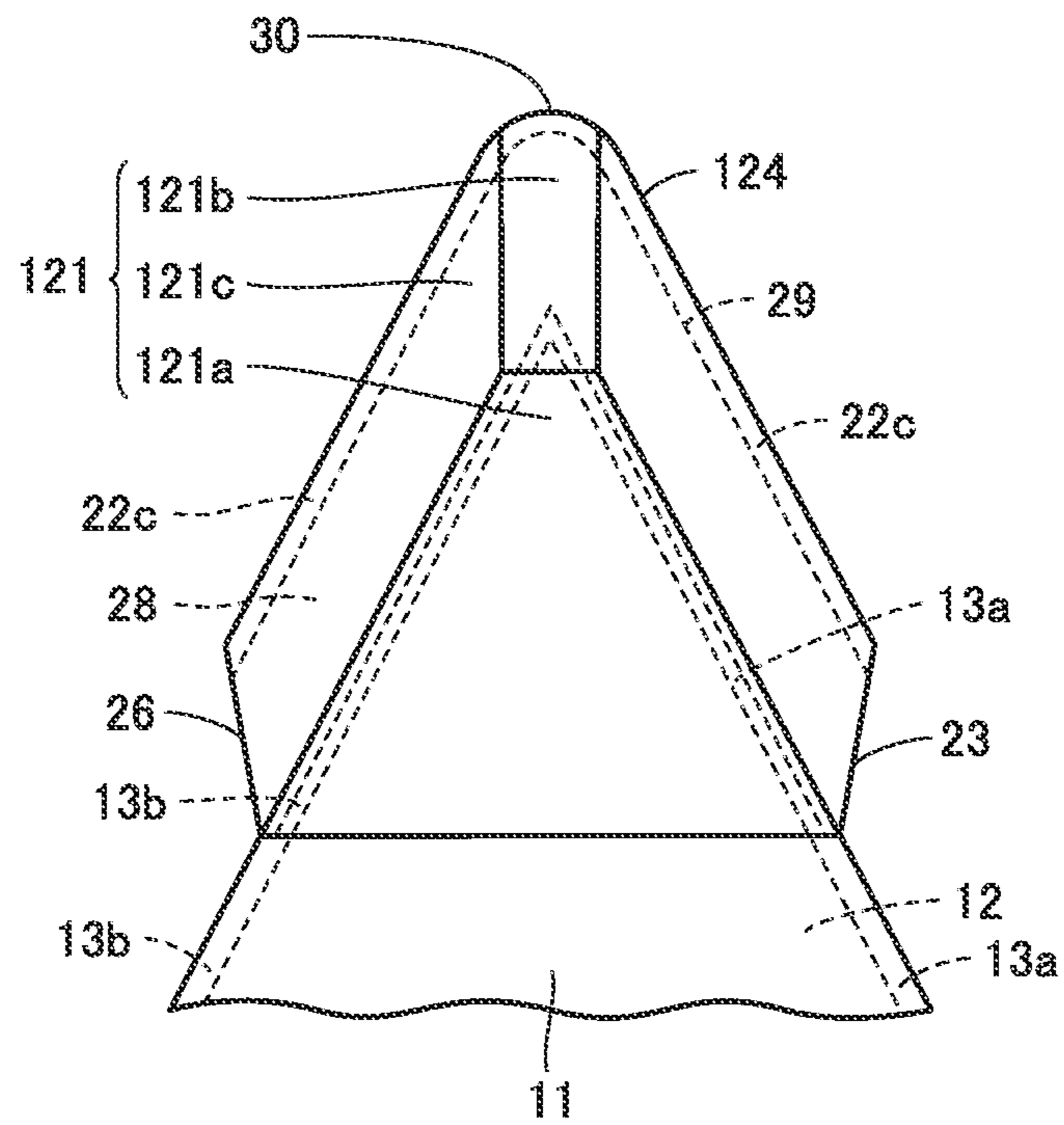


FIG.22



1**THROWAWAY INSERT**

TECHNICAL FIELD

The present invention relates to a throwaway insert. The present application claims a priority based on Japanese Patent Application No. 2016-243351 filed on Dec. 15, 2016, the entire content of which is incorporated herein by reference.

BACKGROUND ART

Japanese Patent Laying-Open No. 11-320219 (Patent Literature 1) discloses a throwaway insert including: a base (base material) having a corner portion provided with a recess; and a cutting edge member (hard sintered material) joined to the recess. The cutting edge member includes: an upper surface; a first side surface flush with a side surface of the base; and a second side surface facing a side surface of the recess. This cutting edge member includes: a first ridgeline formed by the upper surface and the first side surface and serving as a cutting edge; and a second ridgeline formed by the upper surface and the second side surface. The first ridgeline crosses the second ridgeline at an acute angle.

CITATION LIST

Patent Literature

PTL 1: Japanese Patent Laying-Open No. 11-320219

SUMMARY OF INVENTION

A throwaway insert according to one embodiment of the present invention includes a base and a cutting edge member. The base has an upper surface, a lower surface, and a plurality of side surfaces that connect the upper surface to the lower surface, the base being provided with a recess at a corner portion at which the upper surface crosses two side surfaces of the plurality of side surfaces. The cutting edge member is joined to the recess. The cutting edge member includes: a rake face; a flank face extending to cross the rake face; a first connecting face; a second connecting face; and a first ridgeline serving as a cutting edge. The first connecting face connects the flank face to one side surface of the two side surfaces and extends to cross the rake face. The second connecting face connects the flank face to the other side surface of the two side surfaces and extends to cross the rake face. The first ridgeline is formed by the rake face and the flank face. The rake face includes: a main surface extending along the upper surface; and a first chamfer provided at an edge tip portion of the cutting edge member, the edge tip portion including an extreme tip portion of the cutting edge member. The cutting edge includes a first cutting edge part constituted of a first ridgeline part formed by the first chamfer and the flank face. In a plan view from the upper surface of the base, the flank face, the first connecting face, and the second connecting face are located external to the base. The first chamfer is inclined relative to the main surface so as to increase a thickness of the cutting edge member as the first chamfer is closer to the main surface.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic perspective view of a throwaway insert according to a first embodiment.

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FIG. 2 is a schematic plan view of the throwaway insert according to the first embodiment.

FIG. 3 is a schematic partial cross sectional view of the throwaway insert according to the first embodiment along a cross sectional line shown in FIG. 2.

FIG. 4 is a schematic enlarged plan view of the throwaway insert according to the first embodiment at a region IV shown in FIG. 2.

FIG. 5 shows a flowchart of a method of grinding each throwaway insert according to the first and second embodiments.

FIG. 6 is a schematic partial enlarged cross sectional view showing a method of grinding a first chamfer portion of the throwaway insert according to the first embodiment.

FIG. 7 is a schematic perspective view of the throwaway insert according to the second embodiment.

FIG. 8 is a schematic plan view of the throwaway insert according to the second embodiment.

FIG. 9 is a schematic partial cross sectional view of the throwaway insert according to the second embodiment along a cross sectional line IX-IX shown in FIG. 8.

FIG. 10 is a schematic partial cross sectional view of the throwaway insert according to the second embodiment along a cross sectional line X-X shown in FIG. 8.

FIG. 11 is a schematic enlarged plan view of the throwaway insert according to the second embodiment at a region XI shown in FIG. 8.

FIG. 12 is a schematic partial enlarged cross sectional view showing a method of grinding a first chamfer portion of the throwaway insert according to the second embodiment.

FIG. 13 is a schematic partial enlarged cross sectional view showing a method of grinding a second chamfer portion of the throwaway insert according to the second embodiment.

FIG. 14 is a schematic perspective view of a throwaway insert according to a third embodiment.

FIG. 15 is a schematic plan view of the throwaway insert according to the third embodiment.

FIG. 16 is a schematic partial cross sectional view of the throwaway insert according to the third embodiment along a cross sectional line XVI-XVI shown in FIG. 15.

FIG. 17 is a schematic enlarged plan view of the throwaway insert according to the third embodiment at a region XVII shown in FIG. 15.

FIG. 18 is a schematic perspective view of a throwaway insert according to a fourth embodiment.

FIG. 19 is a schematic plan view of the throwaway insert according to the fourth embodiment.

FIG. 20 is a schematic partial cross sectional view of the throwaway insert according to the fourth embodiment along a cross sectional line XX-XX shown in FIG. 19.

FIG. 21 is a schematic partial cross sectional view of the throwaway insert according to the fourth embodiment along a cross sectional line XXI-XXI shown in FIG. 19.

FIG. 22 is a schematic enlarged plan view of the throwaway insert according to the fourth embodiment at a region XXII shown in FIG. 19.

DETAILED DESCRIPTION

Problems to be Solved by the Present Disclosure

The cutting edge member is likely to be chipped when the cutting edge member of the throwaway insert described in Patent Literature 1 is ground and when a workpiece is cut using the throwaway insert described in Patent Literature 1.

Moreover, in the throwaway insert described in Patent Literature 1, it is difficult to increase the number of times of reusing the cutting edge member (the number of times of grinding the cutting edge member).

An object of one embodiment of the present invention is to provide a throwaway insert having stable quality and including a cutting edge member that can be reused a larger number of times.

Advantageous Effect of the Present Disclosure

According to one embodiment of the present invention, there can be provided a throwaway insert having stable quality and including a cutting edge member that can be reused a larger number of times.

DESCRIPTION OF EMBODIMENTS

First, embodiments of the present invention are listed and described.

(1) A throwaway insert **1, 2, 3, 4** according to one embodiment of the present invention includes a base **10, 10c** and a cutting edge member **20, 20b, 20c, 20d**. Base **10, 10c** has an upper surface **11**, a lower surface **12**, and a plurality of side surfaces **13** that connect upper surface **11** to lower surface **12**, base **10, 10c** being provided with a recess **14** at a corner portion at which upper surface **11** crosses two side surfaces (**13a, 13b**) of the plurality of side surfaces **13**. Cutting edge member **20, 20b, 20c, 20d** is joined to recess **14**. Cutting edge member **20, 20b, 20c, 20d** includes: a rake face **21, 121**; a flank face **22, 22c** extending to cross rake face **21, 121**; a first connecting face **23**; a second connecting face **26**; and a first ridgeline (**24, 124**) serving as a cutting edge **24, 124**. First connecting face **23** connects flank face **22, 22c** to one side surface **13a** of the two side surfaces (**13a, 13b**) and extends to cross rake face **21, 121**. Second connecting face **26** connects flank face **22, 22c** to the other side surface **13b** of two side surfaces (**13a, 13b**) and extends to cross rake face **21, 121**. The first ridgeline (**24, 124**) is formed by rake face **21, 121** and flank face **22, 22c**. Rake face **21, 121** includes: a main surface **21a, 121a** extending along upper surface **11**; and a first chamfer **21b, 121b** provided at an edge tip portion of cutting edge member **20, 20b, 20c, 20d**, the edge tip portion including an extreme tip portion **30** of cutting edge member **20, 20b, 20c, 20d**. Cutting edge **24, 124** includes a first cutting edge part **24d, 124d** constituted of a first ridgeline part (**24d, 124d**) formed by first chamfer **21b, 121b** and flank face **22, 22c**. In a plan view from upper surface **11** of base **10, 10c**, flank face **22, 22c**, first connecting face **23**, and second connecting face **26** are located external to base **10, 10c**. First chamfer **21b, 121b** is inclined relative to main surface **21a, 121a** so as to increase a thickness of cutting edge member **20, 20b, 20c, 20d** as first chamfer **21b, 121b** is closer to main surface **21a, 121a**.

First chamfer **21b, 121b** is provided at the edge tip portion of cutting edge member **20, 20b, 20c, 20d**, the edge tip portion including extreme tip portion **30** of cutting edge member **20, 20b, 20c, 20d**. Hence, a damage portion **40, 140** such as breakage and chipping can be suppressed from being produced in cutting edge **24, 124**. Throwaway insert **1, 2, 3, 4** has stable quality.

In the plan view from upper surface **11** of base **10, 10c**, flank face **22, 22c**, first connecting face **23**, and second connecting face **26** are located external to base **10, 10c**. Therefore, when damage portion **40, 140** such as breakage and chipping is produced in cutting edge **24, 124**, damage

portion **40, 140** can be removed by grinding flank face **22, 22c** of cutting edge member **20, 20b, 20c, 20d**. According to throwaway insert **1, 2, 3, 4**, the number of times of reusing cutting edge member **20, 20b, 20c, 20d** can be increased, whereby throwaway insert **1, 2, 3, 4** can be used economically.

First chamfer **21b, 121b** is inclined relative to main surface **21a, 121a** so as to increase the thickness of cutting edge member **20, 20b, 20c, 20d** as first chamfer **21b, 121b** is closer to main surface **21a, 121a**. Accordingly, when flank face **22, 22c** is ground in order to remove damage portion **40, 140**, the thickness of cutting edge member **20, 20b, 20c, 20d** at the first ridgeline (**24, 124**) serving as cutting edge **24, 124** is increased, whereby damage portion **40, 140** such as breakage and chipping is less likely to be produced in cutting edge **24, 124**. Throwaway insert **1, 2, 3, 4** has stable quality.

(2) In throwaway insert **2, 4** according to (1), rake face **121** further includes a second chamfer **121c, 121d** connected to main surface **121a**, first chamfer **121b**, and flank face **22, 22c**. Second chamfer **121c, 121d** is inclined relative to main surface **121a** so as to increase the thickness of cutting edge member **20b, 20d** as second chamfer **121c, 121d** is closer to main surface **121a**. Cutting edge **124** includes a second cutting edge part **124e, 124f** constituted of a second ridgeline part (**124e, 124f**) formed by second chamfer **121c, 121d** and flank face **22, 22c**. In the plan view from upper surface **11** of base **10, 10c**, a first distance d_1 between extreme tip portion **30** of cutting edge member **20b, 20d** and base **10, 10c** is larger than a second distance d_2 between second cutting edge part **124e, 124f** and base **10, 10c**.

In throwaway insert **2, 4**, rake face **121** further includes second chamfer **121c, 121d**. Accordingly, when cutting edge member **20b, 20d** is ground and when a workpiece is cut using throwaway insert **2, 4**, damage portion **40, 140** such as breakage and chipping can be further suppressed from being produced in cutting edge **124**. Throwaway insert **2, 4** has more stable quality.

In throwaway insert **2, 4**, second chamfer **121c, 121d** is inclined relative to main surface **121a** so as to increase the thickness of cutting edge member **20b, 20d** as second chamfer **121c, 121d** is closer to main surface **121a**. Accordingly, when flank face **22, 22c** is ground in order to remove damage portion **40, 140**, the thickness of cutting edge member **20b, 20d** at the first ridgeline (**124**) serving as cutting edge **124** is increased, whereby damage portion **40, 140** is less likely to be produced in cutting edge **124**. Throwaway insert **2, 4** has stable quality.

Extreme tip portion **30** of cutting edge member **20b** is a portion used most to cut a workpiece, and is a portion at which damage portion **40** is most likely to be produced. Since first distance d_1 is larger than second distance d_2 in the plan view from upper surface **11** of base **10, 10c**, the number of times of reusing cutting edge member **20b, 20d** can be increased. Throwaway insert **2, 4** can be used economically.

(3) In throwaway insert **2, 4** according to (2), a first angle θ_1 between first chamfer **121b** and a first extension plane **121e** of main surface **121a** is smaller than a second angle θ_2 between second chamfer **121c, 121d** and first extension plane **121e** of main surface **121a**. Therefore, in the plan view from upper surface **11** of base **10, 10c**, first distance d_1 is larger than second distance d_2 . According to throwaway insert **2, 4**, the number of times of reusing cutting edge member **20b, 20d** can be increased, whereby throwaway insert **2, 4** can be used economically.

(4) In throwaway insert **1, 2, 3, 4** according to (1) or (2), a first angle θ_1 between first chamfer **21b, 121b** and a first extension plane **21e, 121e** of main surface **21a, 121a** is more

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than or equal to 3° and less than or equal to 25° . By setting first angle θ_1 to be more than or equal to 3° , damage portion 40 such as breakage and chipping can be suppressed from being produced in cutting edge 24, 124, and burr can be suppressed from being produced in a workpiece during cutting of the workpiece. Accordingly, throwaway insert 1, 2, 3, 4 has stable quality.

By setting first angle θ_1 to be less than or equal to 25° , even after grinding cutting edge member 20, 20b, 20c, 20d, the cutting edge strength can be secured and a workpiece can be cut with high cutting precision in the same manner as before grinding cutting edge member 20, 20b, 20c, 20d. The cutting performance of cutting edge member 20, 20b, 20c, 20d can be suppressed from being deteriorated after grinding cutting edge member 20, 20b, 20c, 20d.

(5) In throwaway insert 1, 2, 3, 4 according to any one of (1) to (4), extreme tip portion 30 of cutting edge member 20, 20b, 20c, 20d is located on a second extension plane 11e of upper surface 11. Accordingly, even after grinding cutting edge member 20, 20b, 20c, 20d, a workpiece can be cut with high cutting precision in the same manner as before grinding cutting edge member 20, 20b, 20c, 20d. The cutting performance of cutting edge member 20, 20b, 20c, 20d can be suppressed from being deteriorated after grinding cutting edge member 20, 20b, 20c, 20d.

(6) In throwaway insert 3, 4 according to any one of (1) to (5), in the plan view from main surface 21a, 121a, flank face 22c is inclined relative to main surface 21a, 121a so as to be closer to the two side surfaces (13a, 13b) of base 10c as flank face 22c is further away from main surface 21a, 121a. Accordingly, a flank amount of flank face 22c relative to a workpiece can be increased. Flank face 22c is suppressed from being worn during cutting, whereby throwaway insert 3, 4 has a longer life. Further, cuttability of cutting edge 24, 124 is improved. Even though cutting edge member 20c, 20d protrudes relative to the two side surfaces (13a, 13b) of base 10c, occurrence of chatter vibration can be suppressed during cutting of a workpiece, thereby suppressing decrease of cutting precision.

(7) In throwaway insert 3, 4 according to (6), flank face 22c is inclined at an inclination angle θ_5 of more than or equal to 0.1° and less than or equal to 15° relative to an imaginary plane 21v, 121v that is orthogonal to main surface 21a, 121a and that is in contact with the first ridgeline (24, 124). By setting inclination angle θ_5 of flank face 22c to be more than or equal to 0.1° , wear of flank face 22c of cutting edge member 20c, 20d and occurrence of chatter vibration during cutting can be further suppressed. By setting inclination angle θ_5 to be less than or equal to 15° , flank face 22c can be ground using a grindstone without an interference of the grindstone with base 10, 10c.

(8) In throwaway insert 1, 2, 3, 4 according to any one of (1) to (7), a second ridgeline 25, 125 formed by rake face 21, 121 and first connecting face 23 crosses the first ridgeline (24, 124) at an obtuse angle. A third ridgeline 27, 127 formed by rake face 21, 121 and second connecting face 26 crosses the first ridgeline (24, 124) at an obtuse angle. Accordingly, cutting edge member 20, 20b, 20c, 20d can be suppressed from being chipped. Throwaway insert 1, 2, 3, 4 has stable quality.

(9) In throwaway insert 1, 2, 3, 4 according to (8), cutting edge 24, 124 includes: a first straight cutting edge portion 24a, 124a located between first connecting face 23 and first cutting edge part 24d, 124d; and a second straight cutting edge portion 24c, 124c located between second connecting face 26 and first cutting edge part 24d, 124d. When γ (degree) represents an angle between first straight cutting

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edge portion 24a, 124a and second straight cutting edge portion 24c, 124c in the plan view from upper surface 11 of base 10, 10c, each of a first crossing angle α (degree) between the first ridgeline (24, 124) and second ridgeline 25, 125 and a second crossing angle δ (degree) between the first ridgeline (24, 124) and third ridgeline 27, 127 is more than or equal to $(160-\gamma/2)$ and less than or equal to $(200-\gamma/2)$. Therefore, a change in cutting depth of cutting edge member 20, 20b, 20c, 20d into a workpiece before and after grinding of cutting edge member 20, 20b, 20c, 20d can be further decreased.

(10) In throwaway insert 1, 2, 3, 4 according to any one of (1) to (8), cutting edge 24, 124 includes: a first straight cutting edge portion 24a, 124a located between first connecting face 23 and first cutting edge part 24d, 124d; and a second straight cutting edge portion 24c, 124c located between second connecting face 26 and first cutting edge part 24d, 124d. First straight cutting edge portion 24a, 124a is parallel to a first base ridgeline 15a formed by upper surface 11 and one side surface 13a of base 10, 10c. Second straight cutting edge portion 24c, 124c is parallel to a second base ridgeline 15b formed by upper surface 11 and the other side surface 13b of base 10, 10c.

Therefore, cutting edge 24, 124 can be positioned relative to a workpiece with high precision. Precision in cutting a workpiece by throwaway insert 1, 2, 3, 4 can be improved. Cutting edge 24, 124 can be positioned relative to a grindstone with high precision. Precision in grinding cutting edge member 20, 20b, 20c, 20d is improved, thereby obtaining high-quality cutting edge 24, 124.

(11) In throwaway insert 1, 2, 3, 4 according to (10), in the plan view from upper surface 11 of base 10, 10c, a third distance d_3 between first straight cutting edge portion 24a, 124a and first base ridgeline 15a is more than or equal to 0.01 mm and less than or equal to 1 mm. In the plan view from upper surface 11 of base 10, 10c, a fourth distance d_4 between second straight cutting edge portion 24c, 124c and second base ridgeline 15b is more than or equal to 0.01 mm and less than or equal to 1 mm.

By setting each of third distance d_3 and fourth distance d_4 to be less than or equal to 1 mm in the plan view from upper surface 11 of base 10, 10c, the rigidity of cutting edge member 20, 20b, 20c, 20d can be suppressed from being greatly decreased. Accordingly, when cutting a workpiece, chipping of cutting edge member 20, 20b, 20c, 20d and decrease in cutting precision can be suppressed. By setting third distance d_3 and fourth distance d_4 to be more than or equal to 0.01 mm in the plan view from upper surface 11 of base 10, 10c, flank face 22, 22c of cutting edge member 20, 20b, 20c, 20d can be ground while securely preventing grinding of base 10, 10c. Clogging in a grindstone and cracking in throwaway insert 1, 2, 3, 4 can be securely prevented from occurring due to swarf of base 10, 10c during grinding of cutting edge member 20, 20b, 20c, 20d.

(12) In throwaway insert 1, 2, 3, 4 according to any one of (1) to (11), first cutting edge part 24d, 124d includes a curved cutting edge portion 24b, 124b having a protruding curved shape. Curved cutting edge portion 24b, 124b includes extreme tip portion 30. Accordingly, damage portion 40, 140 such as breakage and chipping can be suppressed from being produced in extreme tip portion 30 of throwaway insert 1, 2, 3, 4. Throwaway insert 1, 2, 3, 4 has stable quality.

(13) In throwaway insert 1, 2, 3, 4 according to any one of (1) to (12), cutting edge member 20, 20b, 20c, 20d includes one of the following materials: diamond, cubic boron nitride, cemented carbide and cermet. Throwaway

insert **1**, **2**, **3**, **4** can be used to highly precisely cut workpieces having various hardnesses, such as high-hardness materials or non-iron soft metals.

DETAILS OF EMBODIMENT OF THE PRESENT INVENTION

The following describes details of embodiments of the present invention with reference to figures. It should be noted that in the below-mentioned figures, the same or corresponding portions are given the same reference characters and are not described repeatedly. Moreover, at least a part of configurations of the embodiments described below may be appropriately combined.

First Embodiment

As shown in FIG. **1** to FIG. **4**, a throwaway insert **1** according to the present embodiment mainly includes a base **10** and a cutting edge member **20**. Throwaway insert **1** according to the present embodiment may further include a backing body **18**.

Base **10** has an upper surface **11**, a lower surface **12**, and a plurality of side surfaces **13** that connect upper surface **11** to lower surface **12**. In the present embodiment, in a plan view from upper surface **11** of base **10**, base **10** may have a regular triangle shape. In the present specification, the plan view from upper surface **11** of base **10** means viewing in a direction perpendicular to upper surface **11** of base **10**. The plurality of side surfaces **13** may include a side surface **13a**, a side surface **13b**, and a side surface **13c**. In the plan view from upper surface **11** of base **10**, base **10** may have a polygonal shape such as a rhombus shape (see FIG. **14**, FIG. **15**, FIG. **18** and FIG. **19**), a square shape, a regular pentagon shape, a right hexagon shape or the like.

Further, base **10** is provided with a recess **14** at a corner portion at which upper surface **11** crosses two side surfaces (**13a**, **13b**) of the plurality of side surfaces **13**. Particularly, base **10** is provided with respective recesses **14** at a first corner portion at which upper surface **11** crosses two side surfaces (**13a**, **13b**), a second corner portion at which upper surface **11** crosses two side surfaces (**13b**, **13c**), and a third corner portion at which upper surface **11** crosses two side surfaces (**13c**, **13a**). Recesses **14** may be provided at all the corner portions at each of which upper surface **11** crosses two side surfaces of the plurality of side surfaces **13**. Recess **14** may be provided at at least one of all the corner portions at each of which upper surface **11** crosses two side surfaces of the plurality of side surfaces **13**.

Base **10** further includes: a first base ridgeline **15a** formed by upper surface **11** and one side surface **13a** of the two side surfaces (**13a**, **13b**); and a second base ridgeline **15b** formed by upper surface **11** and the other side surface **13b** of the two side surfaces (**13a**, **13b**). Base **10** is also provided with a through hole **16** extending between the central portion of upper surface **11** and the central portion of lower surface **12**. By fitting a screw or a pressing member into hole **16**, throwaway insert **1** may be attached to a holder (not shown) for cutting or a holder (not shown) for grinding. Cemented carbide may be used as a material of base **10**. Base **10** may be composed of a material having a toughness higher than that of cutting edge member **20**.

Cutting edge member **20** is joined to recess **14** of base **10** using a brazing material or the like. Cutting edge member **20** may be joined to recess **14** of base **10** at the entire surface of recess **14** of base **10**. In the present embodiment, recesses **14** are provided at the first corner portion, second corner

portion, and third corner portion of base **10**. Cutting edge member **20** may be joined to at least one of these recesses **14**.

Cutting edge member **20** includes: a rake face **21**; a flank face **22** extending to cross rake face **21**; a first connecting face **23**; a second connecting face **26**; and a first ridgeline (**24**) serving as a cutting edge **24**. First connecting face **23** connects flank face **22** to one side surface **13a** of the two side surfaces (**13a**, **13b**), and extends to cross rake face **21**. Second connecting face **26** connects flank face **22** to the other side surface **13b** of the two side surfaces (**13a**, **13b**), and extends to cross rake face **21**. The first ridgeline (**24**) is formed by rake face **21** and flank face **22**.

As shown in FIG. **4**, cutting edge member **20** further includes: a second ridgeline **25** formed by rake face **21** and first connecting face **23**; and a third ridgeline **27** formed by rake face **21** and second connecting face **26**. As shown in FIG. **4**, second ridgeline **25** may cross the first ridgeline (**24**) at a first crossing angle α , which is an obtuse angle. First crossing angle α between the first ridgeline (**24**) and second ridgeline **25** is desirably more than or equal to 110° and less than or equal to 165° , and is more desirably more than or equal to 130° and less than or equal to 150° . In the plan view from upper surface **11** of base **10**, an angle β between second ridgeline **25** and first base ridgeline **15a** is desirably more than or equal to 110° and less than or equal to 165° , and is more desirably more than or equal to 130° and less than or equal to 150° . Angle β between second ridgeline **25** and first base ridgeline **15a** may be equal to first crossing angle α between the first ridgeline (**24**) and second ridgeline **25**.

As shown in FIG. **4**, third ridgeline **27** may cross the first ridgeline (**24**) at a second crossing angle δ , which is an obtuse angle. Second crossing angle δ between the first ridgeline (**24**) and third ridgeline **27** is desirably more than or equal to 110° and less than or equal to 165° , and is more desirably more than or equal to 130° and less than or equal to 150° . In the plan view from upper surface **11** of base **10**, an angle ϵ between third ridgeline **27** and second base ridgeline **15b** is desirably more than or equal to 110° and less than or equal to 165° , and is more desirably more than or equal to 130° and less than or equal to 150° . Angle c between third ridgeline **27** and second base ridgeline **15b** may be equal to second crossing angle δ between the first ridgeline (**24**) and third ridgeline **27**. Second crossing angle δ between the first ridgeline (**24**) and third ridgeline **27** may be equal to first crossing angle α between the first ridgeline (**24**) and second ridgeline **25**. Angle c between third ridgeline **27** and second base ridgeline **15b** may be equal to angle β between second ridgeline **25** and first base ridgeline **15a**.

Rake face **21** includes: a main surface **21a** extending along upper surface **11**; and a first chamfer **21b** provided at an edge tip portion of cutting edge member **20**, the edge tip portion including an extreme tip portion **30** of cutting edge member **20**. In the present specification, the expression “main surface **21a** extends along upper surface **11**” means that the main extending direction of main surface **21a** is the same as the main extending direction of upper surface **11**. Specifically, in FIG. **2** and FIG. **4**, each of the main extending direction of main surface **21a** and the main extending direction of upper surface **11** corresponds to an inward direction in the plane of sheet. The expression “main surface **21a** extends along upper surface **11**” encompasses a case where main surface **21a** is not flush with upper surface **11**. As shown in FIG. **1** and FIG. **3**, main surface **21a** may protrude relative to upper surface **11**. The expression “main surface **21a** extends along upper surface **11**” encompasses both the following cases: a case where main surface **21a** is

parallel to upper surface 11; and a case where main surface 21a is not parallel to upper surface 11.

As shown in FIG. 3, extreme tip portion 30 of cutting edge member 20 may be located on a second extension plane 11e of upper surface 11. As shown in FIG. 4, in the plan view from upper surface 11 of base 10, a first distance d_1 between extreme tip portion 30 of cutting edge member 20 and base 10 is larger than a third distance d_3 between first straight cutting edge portion 24a and first base ridgeline 15a. In the present specification, first distance d_1 is defined as a minimum distance between extreme tip portion 30 of cutting edge member 20 and base 10 when upper surface 11 of base 10 is seen in the direction perpendicular to upper surface 11 of base 10. Third distance d_3 is defined as a minimum distance between the first ridgeline (24) and an extension line of first base ridgeline 15a when upper surface 11 of base 10 is seen in the direction perpendicular to upper surface 11 of base 10.

In the plan view from upper surface 11 of base 10, first distance d_1 between extreme tip portion 30 of cutting edge member 20 and base 10 is larger than a fourth distance d_4 between second straight cutting edge portion 24c and second base ridgeline 15b. Fourth distance d_4 is defined as a minimum distance between the first ridgeline (24) and the extension line of second base ridgeline 15b when upper surface 11 of base 10 is seen in the direction perpendicular to upper surface 11 of base 10.

As shown in FIG. 3, first chamfer 21b is inclined relative to main surface 21a so as to increase the thickness of cutting edge member 20 as first chamfer 21b is closer to main surface 21a. A first angle θ_1 between first chamfer 21b and first extension plane 21e of main surface 21a may be more than or equal to 3°, may be preferably more than or equal to 5°, and may be more preferably more than or equal to 7°. By setting first angle θ_1 to be more than or equal to 3°, a damage portion 40 (see FIG. 6) such as breakage and chipping can be suppressed from being produced in cutting edge 24, and burr can be suppressed from being produced in a workpiece during cutting of the workpiece. Accordingly, throwaway insert 1 of the present embodiment has stable quality.

First angle θ_1 between first chamfer 21b and first extension plane 21e of main surface 21a may be less than or equal to 25°, may be preferably less than or equal to 15°, and may be more preferably less than or equal to 10°. By setting first angle θ_1 to be less than or equal to 25°, the thickness of cutting edge member 20 can be prevented from being greatly varied before and after grinding of cutting edge member 20. In the present specification, the thickness of cutting edge member 20 is defined as the length of cutting edge member 20 in the direction perpendicular to main surface 21a. The center height of cutting edge 24 can be prevented from being greatly varied before and after grinding of cutting edge member 20. Accordingly, even after grinding cutting edge member 20, the cutting edge strength can be secured and a workpiece can be cut with high cutting precision in the same manner as before grinding cutting edge member 20. The cutting performance of cutting edge member 20 can be suppressed from being deteriorated after grinding cutting edge member 20.

Cutting edge 24 includes a first cutting edge part 24d constituted of a first ridgeline part (24d) formed by first chamfer 21b and flank face 22. First cutting edge part 24d includes extreme tip portion 30 of cutting edge member 20. In the plan view from upper surface 11 of base 10, flank face 22, first connecting face 23, and second connecting face 26 are located external to base 10 or the two side surfaces (13a,

13b). In the plan view from upper surface 11 of base 10, cutting edge member 20 may cover recess 14 entirely.

As shown in FIG. 4, cutting edge 24 includes: a first straight cutting edge portion 24a located between first connecting face 23 and first cutting edge part 24d; and a second straight cutting edge portion 24c located between second connecting face 26 and first cutting edge part 24d. First straight cutting edge portion 24a and second straight cutting edge portion 24c may be formed by main surface 21a and flank face 22. When γ (degree) represents an angle between first straight cutting edge portion 24a and second straight cutting edge portion 24c in the plan view from upper surface 11 of base 10, each of first crossing angle α (degree) between the first ridgeline (24) and second ridgeline 25 and second crossing angle δ (degree) between the first ridgeline (24) and third ridgeline 27 may be preferably more than or equal to $(160-\gamma/2)$ and less than or equal to $(200-\gamma/2)$, and may be more preferably more than or equal to $(170-\gamma/2)$ and less than or equal to $(190-\gamma/2)$.

First straight cutting edge portion 24a may be connected to first connecting face 23. First straight cutting edge portion 24a may be connected to second ridgeline 25. Second straight cutting edge portion 24c may be connected to second connecting face 26. Second straight cutting edge portion 24c may be connected to third ridgeline 27. First straight cutting edge portion 24a may be parallel to first base ridgeline 15a formed by upper surface 11 and one side surface 13a of base 10. Second straight cutting edge portion 24c may be parallel to second base ridgeline 15b formed by upper surface 11 and the other side surface 13b of base 10.

In the plan view from upper surface 11 of base 10, third distance d_3 between first straight cutting edge portion 24a and first base ridgeline 15a is desirably more than or equal to 0.01 mm and less than or equal to 1 mm, and is more desirably more than or equal to 0.1 mm and less than or equal to 0.6 mm. In the present specification, third distance d_3 in the plan view from upper surface 11 of base 10 is defined as a distance between first straight cutting edge portion 24a and the extension line of first base ridgeline 15a when upper surface 11 of base 10 is seen in the direction perpendicular to upper surface 11 of base 10. In the plan view from upper surface 11 of base 10, fourth distance d_4 between second straight cutting edge portion 24c and second base ridgeline 15b is desirably more than or equal to 0.01 mm and less than or equal to 1 mm, and is more desirably more than or equal to 0.1 mm and less than or equal to 0.6 mm. In the present specification, fourth distance d_4 in the plan view from upper surface 11 of base 10 is defined as a distance between second straight cutting edge portion 24c and the extension line of second base ridgeline 15b when upper surface 11 of base 10 is seen in the direction perpendicular to upper surface 11 of base 10. Fourth distance d_4 may be equal to third distance d_3 .

First cutting edge part 24d may include a curved cutting edge portion 24b having a protruding curved shape. Particularly, curved cutting edge portion 24b may have a protruding arc shape. Curved cutting edge portion 24b may include extreme tip portion 30 of cutting edge member 20. Curved cutting edge portion 24b may be formed by first chamfer 21b and flank face 22. Curved cutting edge portion 24b is located between first straight cutting edge portion 24a and second straight cutting edge portion 24c. Curved cutting edge portion 24b is connected to first straight cutting edge portion 24a and second straight cutting edge portion 24c.

First cutting edge part 24d may include a third straight cutting edge portion 24e and a fourth straight cutting edge portion 24f. Third straight cutting edge portion 24e and

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fourth straight cutting edge portion **24f** may be formed by first chamfer **21b** and flank face **22**. Third straight cutting edge portion **24e** may be connected to first straight cutting edge portion **24a** and curved cutting edge portion **24b**. Fourth straight cutting edge portion **24f** may be connected to second straight cutting edge portion **24c** and curved cutting edge portion **24b**.

In throwaway insert **1** of the present embodiment, cutting edge member **20** may include one of the following materials: diamond, cubic boron nitride, cemented carbide and cermet. Cutting edge member **20** including the diamond may be a diamond sintered material. Cutting edge member **20** including the cubic boron nitride (CBN) may be a cubic boron nitride (CBN) sintered material including more than or equal to 20 volume % of the cubic boron nitride (CBN). The cemented carbide may include, as a main component, tungsten carbide (WC) having at least one of cobalt (Co), titanium carbide (TiC), titanium nitride (TiN), and titanium carbonitride (TiCN) added therein. The cermet may include titanium carbide (TiC), titanium nitride (TiN), or titanium carbonitride (TiCN) as a main component. Cutting edge member **20** is composed of a material having a hardness higher than that of base **10**.

Backing body **18** may be located between recess **14** of base **10** and cutting edge member **20**. Backing body **18** is composed of a material having a toughness higher than that of cutting edge member **20**. Accordingly, even when a large load acts on cutting edge **24** during cutting, part of this load can be absorbed by backing body **18**. Backing body **18** prevents concentration of this load on cutting edge member **20**, and prevents cutting edge **24** from being chipped during cutting. Backing body **18** can extend the life of throwaway insert **1**. Throwaway insert **1** including backing body **18** has more stable quality. Cemented carbide may be used as a material of backing body **18**.

As shown in FIG. 3, a side surface **18s** of backing body **18** may be flush with flank face **22** of cutting edge member **20**. As one modification of the present embodiment, side surface **18s** of backing body **18** may be flush with the two side surfaces (**13a**, **13b**) of base **10**, and flank face **22** of cutting edge member **20** may protrude relative to the two side surfaces (**13a**, **13b**) of base **10** and side surface **18s** of backing body **18**. Backing body **18** may be integrated with cutting edge member **20**. Cutting edge member **20** and backing body **18** may be a composite sintered material obtained by sintering and shaping cutting edge member **20** and backing body **18** integrally.

The following describes an exemplary method of manufacturing throwaway insert **1** of the present embodiment. The composite sintered material is obtained by sintering and shaping cutting edge member **20** and backing body **18** integrally. This composite sintered material is joined to recess **14** of base **10** using a brazing material or the like with backing body **18** of this composite sintered material facing recess **14** of base **10**. By grinding flank face **22** including the first ridgeline (**24**) without grinding base **10**, cutting edge **24** is formed at the first ridgeline (**24**). In this way, throwaway insert **1** of the present embodiment can be manufactured.

The following describes an exemplary method of cutting a workpiece using throwaway insert **1** of the present embodiment. Throwaway insert **1** is held at a holder for cutting. The first ridgeline (**24**) serving as cutting edge **24** is brought into contact with a workpiece and the workpiece is rotated with respect to throwaway insert **1**. In this way, the workpiece is cut using throwaway insert **1** of the present embodiment.

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With reference to FIG. 5, the following describes an exemplary method of grinding cutting edge **24** of throwaway insert **1** of the present embodiment. Throwaway insert **1** is held at a holder for grinding (S1). Flank face **22** including cutting edge **24** is brought into contact with a grindstone to grind flank face **22**. Specifically, first, flank face **22** may be ground to grind first straight cutting edge portion **24a** and second straight cutting edge portion **24c** (S2). On this occasion, third straight cutting edge portion **24e** and fourth straight cutting edge portion **24f** may also be ground. Then, flank face **22** may be ground to grind curved cutting edge portion **24b** (S3). In this way, cutting edge **24** of throwaway insert **1** of the present embodiment is ground.

In throwaway insert **1** of the present embodiment, in the plan view from upper surface **11** of base **10**, flank face **22**, first connecting face **23**, and second connecting face **26** are located external to base **10**. Accordingly, as shown in FIG. 6, when a damage portion **40** is produced in cutting edge member **20** during cutting of a workpiece using throwaway insert **1**, flank face **22** can be ground, thereby removing damage portion **40**.

Specifically, as shown in FIG. 6, during cutting of a workpiece using throwaway insert **1**, a damage portion **40** having a width w_1 and a height h_1 is produced in cutting edge **24** (first cutting edge part **24d**) formed by first chamfer **21b** and flank face **22**. By grinding flank face **22** by a grinding width w_3 , i.e., by grinding flank face **22** to a grinding line **41**, damage portion **40** can be removed. Grinding width w_3 is larger than width w_1 of damage portion **40**.

Then, during cutting of a workpiece using throwaway insert **1**, a damage portion **40** having width w_1 and height h_1 is produced again in cutting edge member **20**. By grinding flank face **22** by grinding width w_3 , i.e., by grinding flank face **22** to a grinding line **42**, damage portion **40** can be removed. Likewise, whenever a damage portion **40** having width w_1 and height h_1 is produced in cutting edge member **20**, flank face **22** is ground by grinding width w_3 , thereby removing damage portion **40**. Cutting edge member **20** can be ground five times to grinding lines **41**, **42**, **43**, **44**, **45**, whereby throwaway insert **1** of the present embodiment can be reused five times.

Each of amounts of protrusion of flank face **22**, first connecting face **23**, and second connecting face **26** relative to the two side surfaces (**13a**, **13b**) of base **10** in the plan view from upper surface **11** of base **10** is preferably such an amount of protrusion that throwaway insert **1** may be reused twice or more. Each of amounts of protrusion of flank face **22**, first connecting face **23**, and second connecting face **26** relative to the two side surfaces (**13a**, **13b**) of base **10** in the plan view from upper surface **11** of base **10** may be more than or equal to 0.01 mm, for example.

As shown in FIG. 6, in throwaway insert **1** of the present embodiment, first chamfer **21b** is inclined relative to main surface **21a** so as to increase the thickness of cutting edge member **20** as first chamfer **21b** is closer to main surface **21a**. Accordingly, when flank face **22** is ground in order to remove damage portion **40**, the thickness of cutting edge member **20** at the first ridgeline (**24**) serving as cutting edge **24** is increased.

The following describes functions and effects of throwaway insert **1** of the present embodiment.

Throwaway insert **1** of the present embodiment includes base **10** and cutting edge member **20**. Base **10** has upper surface **11**, lower surface **12**, and the plurality of side surfaces **13** that connect upper surface **11** to lower surface **12**, base **10** being provided with recess **14** at the corner portion at which upper surface **11** crosses two side surfaces

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(13a, 13b) of the plurality of side surfaces 13. Cutting edge member 20 is joined to recess 14. Cutting edge member 20 includes: rake face 21; flank face 22 extending to cross rake face 21; first connecting face 23; second connecting face 26; and the first ridgeline (24) serving as cutting edge 24. First connecting face 23 connects flank face 22 to one side surface 13a of the two side surfaces (13a, 13b), and extends to cross rake face 21. Second connecting face 26 connects flank face 22 to the other side surface 13b of the two side surfaces (13a, 13b), and extends to cross rake face 21. The first ridgeline (24) is formed by rake face 21 and flank face 22. Rake face 21 includes: main surface 21a extending along upper surface 11; and first chamfer 21b provided at the edge tip portion of cutting edge member 20, the edge tip portion including extreme tip portion 30 of cutting edge member 20. Cutting edge 24 includes first cutting edge part 24d constituted of the first ridgeline part (24d) formed by first chamfer 21b and flank face 22. In the plan view from upper surface 11 of base 10, flank face 22, first connecting face 23, and second connecting face 26 are located external to base 10. First chamfer 21b is inclined relative to main surface 21a so as to increase the thickness of cutting edge member 20 as first chamfer 21b is closer to main surface 21a.

In throwaway insert 1 of the present embodiment, first chamfer 21b is provided at the edge tip portion of cutting edge member 20, the edge tip portion including extreme tip portion 30 of cutting edge member 20. Accordingly, when cutting edge member 20 is ground and when a workpiece is cut using throwaway insert 1, damage portion 40 such as breakage and chipping can be suppressed from being produced in cutting edge 24. Throwaway insert 1 of the present embodiment has stable quality.

In throwaway insert 1 of the present embodiment, in the plan view from upper surface 11 of base 10, flank face 22, first connecting face 23, and second connecting face 26 are located external to base 10. Therefore, when damage portion 40 is produced in cutting edge 24 while cutting a workpiece using throwaway insert 1, damage portion 40 can be removed by grinding flank face 22 of cutting edge member 20.

Generally, width w_1 of damage portion 40 in the direction parallel to main surface 21a of rake face 21 is smaller than height h_1 of damage portion 40 in the direction perpendicular to main surface 21a of rake face 21. A required amount of grinding of cutting edge member 20 to remove damage portion 40 in throwaway insert 1 of the present embodiment in which flank face 22 is ground can be reduced as compared with a first comparative example in which rake face 21 is ground. In throwaway insert 1 of the present embodiment, the grinding of cutting edge member 20 to remove damage portion 40 in cutting edge member 20 can be performed a larger number of times. According to throwaway insert 1 of the present embodiment, the number of times of reusing cutting edge member 20 can be increased, whereby throwaway insert 1 of the present embodiment can be used economically.

In throwaway insert 1 of the present embodiment, first chamfer 21b is inclined relative to main surface 21a so as to increase the thickness of cutting edge member 20 as first chamfer 21b is closer to main surface 21a. Accordingly, when flank face 22 is ground in order to remove damage portion 40, the thickness of cutting edge member 20 at the first ridgeline (24) serving as cutting edge 24 is increased, whereby damage portion 40 is less likely to be produced in cutting edge 24. Throwaway insert 1 of the present embodiment has stable quality.

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In throwaway insert 1 of the present embodiment, cutting edge member 20 including first chamfer 21b is ground only by grinding flank face 22 to remove damage portion 40. On the other hand, in the throwaway insert of the first comparative example, cutting edge member 20 including first chamfer 21b is ground by grinding rake face 21 to remove damage portion 40 and then grinding a portion of rake face 21 again to form first chamfer 21b. According to throwaway insert 1 of the present embodiment, cutting edge member 20 including first chamfer 21b is ground with a smaller number of grinding steps.

In throwaway insert 1 of the present embodiment, in the plan view from upper surface 11 of base 10, flank face 22, first connecting face 23, and second connecting face 26 are located external to base 10. Accordingly, flank face 22 can be ground without grinding base 10. According to throwaway insert 1 of the present embodiment, clogging in a grindstone and cracking in throwaway insert 1 can be prevented from occurring due to swarf of base 10 during grinding of cutting edge member 20.

In throwaway insert 1 of the present embodiment, in the plan view from upper surface 11 of base 10, flank face 22, first connecting face 23, and second connecting face 26 are located external to base 10. Therefore, cutting edge member 20 can be joined to base 10 at the entire surface of recess 14 of base 10. According to throwaway insert 1 of the present embodiment, cutting edge member 20 can be firmly joined to base 10.

In throwaway insert 1 of the present embodiment, first angle θ_1 between first chamfer 21b and first extension plane 21e of main surface 21a may be more than or equal to 3° and less than or equal to 25° . By setting first angle θ_1 to be more than or equal to 3° , damage portion 40 can be suppressed from being produced in cutting edge 24, and burr can be suppressed from being produced in a workpiece during cutting of the workpiece. Accordingly, throwaway insert 1 having stable quality can be provided.

By setting first angle θ_1 to be less than or equal to 25° , the thickness of cutting edge member 20 can be prevented from being greatly varied before and after grinding of cutting edge member 20. The center height of cutting edge 24 can be prevented from being greatly varied before and after grinding of cutting edge member 20. Hence, even after grinding cutting edge member 20, the cutting edge strength can be secured and a workpiece can be cut with high cutting precision in the same manner as before grinding cutting edge member 20. The cutting performance of cutting edge member 20 can be suppressed from being deteriorated after grinding cutting edge member 20.

In throwaway insert 1 of the present embodiment, extreme tip portion 30 of cutting edge member 20 may be located on second extension plane 11e of upper surface 11. Accordingly, the center height of cutting edge 24 can be defined precisely. Even after grinding cutting edge member 20, a workpiece can be cut with high cutting precision in the same manner as before grinding cutting edge member 20. The cutting performance of cutting edge member 20 can be suppressed from being deteriorated after grinding cutting edge member 20.

In throwaway insert 1 of the present embodiment, second ridgeline 25 formed by rake face 21 and first connecting face 23 may cross the first ridgeline (24) at an obtuse angle. Third ridgeline 27 formed by rake face 21 and second connecting face 26 may cross the first ridgeline (24) at an obtuse angle. Therefore, as compared with a throwaway insert of a second comparative example in which second ridgeline 25 and third ridgeline 27 cross the first ridgeline (24) at an acute angle,

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according to throwaway insert **1** of the present embodiment, mechanical strength can be improved at a first end portion of cutting edge member **20** and a second end portion of cutting edge member **20**. The first end portion of cutting edge member **20** is a region at which flank face **22** and first connecting face **23** cross each other, and the second end portion of cutting edge member **20** is a region at which flank face **22** and second connecting face **26** cross each other. In throwaway insert **1** of the present embodiment, the first end portion and second end portion of cutting edge member **20** can be suppressed from being chipped when grinding cutting edge member **20**. Throwaway insert **1** of the present embodiment has stable quality.

Moreover, as compared with the throwaway insert of the second comparative example in which second ridgeline **25** and third ridgeline **27** cross the first ridgeline (**24**) at an acute angle, according to throwaway insert **1** of the present embodiment, a change in length of cutting edge **24** before and after grinding cutting edge member **20** can be made small. A change in cutting depth of cutting edge member **20** into a workpiece before and after grinding of cutting edge member **20** can be decreased.

In throwaway insert **1** of the present embodiment, cutting edge **24** may include: first straight cutting edge portion **24a** located between first connecting face **23** and first cutting edge part **24d**; and second straight cutting edge portion **24c** located between second connecting face **26** and first cutting edge part **24d**. When γ (degree) represents an angle between first straight cutting edge portion **24a** and second straight cutting edge portion **24c** in the plan view from upper surface **11** of base **10**, each of a first crossing angle α (degree) between the first ridgeline (**24**) and second ridgeline **25** and a second crossing angle δ (degree) between the first ridgeline (**24**) and third ridgeline **27** may be more than or equal to $(160-\gamma/2)$ and less than or equal to $(200-\gamma/2)$.

Accordingly, the first length of first straight cutting edge portion **24a** after grinding is substantially unchanged from the first length of first straight cutting edge portion **24a** before grinding, and the second length of second straight cutting edge portion **24c** after grinding is substantially unchanged from the second length of second straight cutting edge portion **24c** before grinding. According to throwaway insert **1** of the present embodiment, a change in cutting depth of cutting edge member **20** into a workpiece before and after grinding of cutting edge member **20** can be further decreased.

In throwaway insert **1** of the present embodiment, cutting edge **24** includes: first straight cutting edge portion **24a** located between first connecting face **23** and first cutting edge part **24d**; and second straight cutting edge portion **24c** located between second connecting face **26** and first cutting edge part **24d**. First straight cutting edge portion **24a** may be parallel to first base ridgeline **15a** formed by upper surface **11** and one side surface **13a** of base **10**. Second straight cutting edge portion **24c** may be parallel to second base ridgeline **15b** formed by upper surface **11** and the other side surface **13b** of base **10**.

Each of the plurality of side surfaces **13** of base **10** is positioned precisely. First straight cutting edge portion **24a** is parallel to first base ridgeline **15a** included in one side surface **13a**. Second straight cutting edge portion **24c** is parallel to second base ridgeline **15b** included in the other side surface **13b**. Accordingly, when at least one of the two side surfaces (**13a**, **13b**) of base **10** is bound to a holder for cutting or a holder for grinding, the at least one of the two side surfaces (**13a**, **13b**) of base **10** may be used as a positional reference of cutting edge **24**. Cutting edge **24** can

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be positioned relative to a workpiece with high precision. Precision in cutting a workpiece by throwaway insert **1** can be improved. Cutting edge **24** can be positioned relative to a grindstone with high precision. Precision in grinding cutting edge member **20** is improved, thereby obtaining high-quality cutting edge **24**.

In throwaway insert **1** of the present embodiment, in the plan view from upper surface **11** of base **10**, third distance d_3 between first straight cutting edge portion **24a** and first base ridgeline **15a** may be more than or equal to 0.01 mm and less than or equal to 1 mm. In the plan view from upper surface **11** of base **10**, fourth distance d_4 between second straight cutting edge portion **24c** and second base ridgeline **15b** may be more than or equal to 0.01 mm and less than or equal to 1 mm.

By setting each of third distance d_3 and fourth distance d_4 to be less than or equal to 1 mm in the plan view from upper surface **11** of base **10**, an amount of protrusion of cutting edge member **20** relative to base **10** can be prevented from being too large. The rigidity of cutting edge member **20** can be suppressed from being significantly decreased. When cutting a workpiece, cutting edge member **20** can be suppressed from being chipped. Throwaway insert **1** has stable quality. Moreover, since the rigidity of cutting edge member **20** can be suppressed from being significantly decreased, occurrence of chatter vibration can be prevented during cutting of a workpiece. The cutting precision can be suppressed from being decreased.

By setting each of third distance d_3 and fourth distance d_4 to be more than or equal to 0.01 mm, flank face **22** of cutting edge member **20** can be ground while securely preventing grinding of base **10**. In throwaway insert **1** of the present embodiment, clogging in a grindstone and cracking in throwaway insert **1** can be prevented from occurring due to swarf of base **10** during grinding of cutting edge member **20**.

In throwaway insert **1** of the present embodiment, first cutting edge part **24d** may include a curved cutting edge portion **24b** having a protruding curved shape. Curved cutting edge portion **24b** may include extreme tip portion **30**. Accordingly, damage portion **40** can be suppressed from being produced in extreme tip portion **30** of throwaway insert **1**. Throwaway insert **1** of the present embodiment has stable quality.

In throwaway insert **1** of the present embodiment, cutting edge member **20** may include one of the following materials: diamond, cubic boron nitride, cemented carbide and cermet. Throwaway insert **1** of the present embodiment can be used to highly precisely cut workpieces having various hardnesses, such as high-hardness materials or non-iron soft metals.

Second Embodiment

With reference to FIG. 7 to FIG. 11, the following describes a throwaway insert **2** of a second embodiment. Throwaway insert **2** of the present embodiment includes the same configuration as that of throwaway insert **1** of the first embodiment, but is different therefrom in a configuration of a cutting edge member **20b**.

Cutting edge member **20b** includes: a rake face **121**; flank face **22** extending to cross rake face **121**; first connecting face **23**; second connecting face **26**; and a first ridgeline (**124**) serving as a cutting edge **124**. First connecting face **23** connects flank face **22** to one side surface **13a** of the two side surfaces (**13a**, **13b**), and extends to cross rake face **121**. Second connecting face **26** connects flank face **22** to the other side surface **13b** of the two side surfaces (**13a**, **13b**),

and extends to cross rake face **121**. The first ridgeline (**124**) is formed by rake face **121** and flank face **22**.

Rake face **121** includes: a main surface **121a**; a first chamfer **121b** provided at an edge tip portion of cutting edge member **20b**, the edge tip portion including an extreme tip portion **30** of cutting edge member **20b**; and second chamfers **121c**, **121d** each connected to main surface **121a**, first chamfer **121b**, and flank face **22**. Main surface **121a** and first chamfer **121b** of the present embodiment respectively have the same configurations as those of main surface **21a** and first chamfer **21b** of the first embodiment. Each of second chamfers **121c**, **121d** is inclined relative to main surface **121a** so as to increase a thickness of cutting edge member **20b** as each of second chamfers **121c**, **121d** is closer to main surface **121a**. Second chamfer **121c** may be connected to first connecting face **23**. Second chamfer **121d** may be connected to second connecting face **26**.

As shown in FIG. **11**, cutting edge member **20b** further includes: a second ridgeline **125** formed by rake face **121** and first connecting face **23**; and a third ridgeline **127** formed by rake face **121** and second connecting face **26**. Second ridgeline **125** may be formed by second chamfer **121c** and first connecting face **23**. Third ridgeline **127** may be formed by second chamfer **121c** and second connecting face **26**.

Cutting edge **124** includes a first cutting edge part **124d** and second cutting edge parts **124e**, **124f**. First cutting edge part **124d** is constituted of a first ridgeline part (**124d**) formed by first chamfer **121b** and flank face **22**. Second cutting edge parts **124e**, **124f** are constituted of second ridgeline parts (**124e**, **124f**) formed by second chamfers **121c**, **121d** and flank face **22**. First cutting edge part **124d** is located between second cutting edge part **124e** and second cutting edge part **124f**. First cutting edge part **124d** is connected to second cutting edge part **124e** and second cutting edge part **124f**.

In the plan view from upper surface **11** of base **10**, a first distance d_1 between extreme tip portion **30** of cutting edge member **20b** and base **10** is larger than a second distance d_2 between each of second cutting edge parts **124e**, **124f** and base **10**. In the present specification, second distance d_2 is defined as a minimum distance between each of second cutting edge parts **124e**, **124f** and an extension line of first base ridgeline **15a** when upper surface **11** of base **10** is seen in the direction perpendicular to upper surface **11** of base **10**.

As shown in FIG. **9** and FIG. **10**, a first angle θ_1 between first chamfer **121b** and first extension plane **121e** of main surface **121a** is smaller than a second angle θ_2 between each of second chamfers **121c**, **121d** and first extension plane **121e** of main surface **121a**. First angle θ_1 may be more than or equal to 3° , may be preferably more than or equal to 5° , and may be more preferably more than or equal to 7° . First angle θ_1 may be less than or equal to 25° , may be preferably less than or equal to 15° , and may be more preferably less than or equal to 10° .

Second angle θ_2 may be more than or equal to 3° , may be preferably more than or equal to 10° , and may be more preferably more than or equal to 12° . By setting second angle θ_2 to be more than or equal to 3° , a damage portion **140** (see FIG. **13**) such as breakage and chipping can be further suppressed from being produced in cutting edge **124**. Accordingly, throwaway insert **2** having stable quality can be provided.

Second angle θ_2 may be less than or equal to 25° , may be preferably less than or equal to 20° , and may be more preferably less than or equal to 18° . By setting second angle θ_2 to be less than or equal to 25° , the thickness of cutting

edge member **20b** can be prevented from being greatly varied before and after grinding of cutting edge member **20b**. The center height of cutting edge **124** can be prevented from being greatly varied before and after grinding of cutting edge member **20b**. Accordingly, even after grinding cutting edge member **20b**, a workpiece can be cut with high cutting precision in the same manner as before grinding cutting edge member **20b**. The cutting performance of cutting edge member **20b** can be suppressed from being deteriorated after grinding cutting edge member **20b**.

As shown in FIG. **11**, cutting edge **124** includes: a first straight cutting edge portion **124a** located between first connecting face **23** and first cutting edge part **124d**; and a second straight cutting edge portion **124c** located between second connecting face **26** and first cutting edge part **124d**. First straight cutting edge portion **124a** and second straight cutting edge portion **124c** may be formed by second chamfers **121c**, **121d** and flank face **22**.

As shown in FIG. **11**, in the plan view from upper surface **11** of base **10**, a first distance d_1 between extreme tip portion **30** of cutting edge member **20b** and base **10** is larger than a third distance d_3 between first straight cutting edge portion **124a** and first base ridgeline **15a**. In the plan view from upper surface **11** of base **10**, first distance d_1 between extreme tip portion **30** of cutting edge member **20b** and base **10** is larger than a fourth distance d_4 between second straight cutting edge portion **124c** and second base ridgeline **15b**.

First straight cutting edge portion **124a** may be parallel to first base ridgeline **15a** formed by upper surface **11** and one side surface **13a** of base **10**. Second straight cutting edge portion **124c** may be parallel to second base ridgeline **15b** formed by upper surface **11** and the other side surface **13b** of base **10**.

In the plan view from upper surface **11** of base **10**, third distance d_3 between first straight cutting edge portion **124a** and first base ridgeline **15a** is desirably more than or equal to 0.01 mm and less than or equal to 1 mm, and is more desirably more than or equal to 0.1 mm and less than or equal to 0.6 mm. In the plan view from upper surface **11** of base **10**, fourth distance d_4 between second straight cutting edge portion **124c** and second base ridgeline **15b** is desirably more than or equal to 0.01 mm and less than or equal to 1 mm, and is more desirably more than or equal to 0.1 mm and less than or equal to 0.6 mm. Fourth distance d_4 in the plan view from upper surface **11** of base **10** may be equal to third distance d_3 in the plan view from upper surface **11** of base **10**.

By setting each of third distance d_3 and fourth distance d_4 to be less than or equal to 1 mm in the plan view from upper surface **11** of base **10**, the rigidity of cutting edge member **20b** can be suppressed from being greatly decreased. Accordingly, when cutting a workpiece, chipping of cutting edge member **20b** and decrease in cutting precision can be suppressed. By setting third distance d_3 and fourth distance d_4 to be more than or equal to 0.01 mm in the plan view from upper surface **11** of base **10**, flank face **22** of cutting edge member **20b** can be ground while securely preventing grinding of base **10**. Clogging in a grindstone and cracking in throwaway insert **2** can be securely prevented from occurring due to swarf of base **10** during grinding of cutting edge member **20b**.

When γ (degree) represents an angle between first straight cutting edge portion **124a** and second straight cutting edge portion **124c** in the plan view from upper surface **11** of base **10**, each of a first crossing angle α (degree) between the first ridgeline (**124**) and second ridgeline **125** and a second crossing angle δ (degree) between the first ridgeline (**124**)

and third ridgeline **127** may be preferably more than or equal to $(160-\gamma/2)$ and less than or equal to $(200-\gamma/2)$, and may be more preferably more than or equal to $(170-\gamma/2)$ and less than or equal to $(190-\gamma/2)$. Therefore, a change in cutting depth of cutting edge member **20** into a workpiece before and after grinding of cutting edge member **20b** can be decreased.

First cutting edge part **124d** may include a curved cutting edge portion **124b** having a protruding curved shape. Particularly, curved cutting edge portion **124b** may have a protruding arc shape. Curved cutting edge portion **124b** may include extreme tip portion **30** of cutting edge member **20b**. Curved cutting edge portion **124b** is formed by first chamfer **121b**, portions of second chamfers **121c**, **121d**, and flank face **22**. Curved cutting edge portion **124b** is located between first straight cutting edge portion **124a** and second straight cutting edge portion **124c**. Curved cutting edge portion **124b** is connected to first straight cutting edge portion **124a** and second straight cutting edge portion **124c**.

Second cutting edge part **124e** may include a portion of curved cutting edge portion **124b** and first straight cutting edge portion **124a**. Second cutting edge part **124f** may include a portion of curved cutting edge portion **124b** and second straight cutting edge portion **124c**. Extreme tip portion **30** of cutting edge member **20b** is located between second cutting edge parts **124e**, **124f**. Accordingly, a larger amount of extreme tip portion **30** of cutting edge member **20b** is ground than those of second cutting edge parts **124e**, **124f**.

With reference to FIG. 5, the following describes an exemplary method of grinding cutting edge **124** of throwaway insert **2** of the present embodiment. Throwaway insert **2** is held at a holder for grinding (S1). Flank face **22** including cutting edge **124** is brought into contact with a grindstone to grind flank face **22**. Specifically, first, flank face **22** may be ground to grind first straight cutting edge portion **124a** and second straight cutting edge portion **124c** (S2). Then, flank face **22** may be ground to grind curved cutting edge portion **124b** (S3). In this way, cutting edge **124** of throwaway insert **2** of the present embodiment is ground.

In throwaway insert **2** of the present embodiment, in the plan view from upper surface **11** of base **10**, flank face **22**, first connecting face **23**, and second connecting face **26** are located external to base **10**. Accordingly, as shown in FIG. 12 and FIG. 13, when damage portions **40**, **140** such as breakage and chipping are produced in cutting edge member **20b** during cutting of a workpiece using throwaway insert **2**, flank face **22** of cutting edge member **20b** can be ground, thereby removing damage portions **40**, **140**.

Specifically, as shown in FIG. 12, when a damage portion **40** having width w_1 and height h_1 is produced in cutting edge **124** (first cutting edge part **124d**) formed by first chamfer **121b** and flank face **22** during cutting of a workpiece using throwaway insert **2**, damage portion **40** can be removed by grinding flank face **22** by a grinding width w_3 , i.e., by grinding flank face **22** to a grinding line **41**. Grinding width w_3 is larger than width w_1 of damage portion **40**.

Then, during cutting of a workpiece using throwaway insert **2**, when a damage portion **40** having width w_1 and height h_1 is produced again in cutting edge member **20b**, damage portion **40** can be removed by grinding flank face **22** by grinding width w_3 , i.e., by grinding flank face **22** to a grinding line **42**. Likewise, whenever a damage portion **40** having width w_1 and height h_1 is produced in cutting edge member **20b**, flank face **22** is ground by grinding width w_3 , thereby removing damage portion **40**. Cutting edge member

20b can be ground five times to grinding lines **41**, **42**, **43**, **44**, **45**, whereby throwaway insert **2** of the present embodiment can be reused five times.

As shown in FIG. 13, when a damage portion **140** having a width w_2 and a height h_2 is produced in cutting edge **124** (second cutting edge part **124f**) formed by second chamfer **121d** and flank face **22** during cutting of a workpiece using throwaway insert **2**, damage portion **140** can be removed by grinding flank face **22** by a grinding width w_4 , i.e., by grinding flank face **22** to a grinding line **141**. Grinding width w_4 is larger than width w_2 of damage portion **140**.

Then, during cutting of a workpiece using throwaway insert **2**, when a damage portion **140** having width w_2 and height h_2 is produced again in cutting edge member **20**, damage portion **140** can be removed by grinding flank face **22** by grinding width w_4 , i.e., by grinding flank face **22** to a grinding line **142**. Likewise, whenever a damage portion **140** having width w_2 and height h_2 is produced in cutting edge member **20b**, flank face **22** of cutting edge member **20b** is ground by grinding width w_4 , thereby removing damage portion **140**. Cutting edge member **20b** can be ground five times to grinding lines **141**, **142**, **143**, **144**, **145**, whereby throwaway insert **2** of the present embodiment can be reused five times. Although it has been described that damage portion **140** is produced in cutting edge **124** (second cutting edge part **124f**) formed by second chamfer **121d** and flank face **22**, the same applies to a case where damage portion **140** is produced in cutting edge **124** (second cutting edge part **124e**) formed by second chamfer **121c** and flank face **22**.

Extreme tip portion **30** of cutting edge member **20b** is located between second cutting edge parts **124e**, **124f**. Therefore, grinding width w_3 at extreme tip portion **30** is larger than grinding width w_4 at cutting edge **124** (second cutting edge part **124f**) formed by second chamfer **121d** and flank face **22**.

Each of amounts of protrusion of flank face **22**, first connecting face **23**, and second connecting face **26** relative to the two side surfaces (**13a**, **13b**) of base **10** in the plan view from upper surface **11** of base **10** is preferably such an amount of protrusion that throwaway insert **2** can be reused twice or more. Each of amounts of protrusion of flank face **22**, first connecting face **23**, and second connecting face **26** relative to the two side surfaces (**13a**, **13b**) of base **10** in the plan view from upper surface **11** of base **10** may be more than or equal to 0.01 mm, for example.

As shown in FIG. 12 and FIG. 13, in throwaway insert **2** of the present embodiment, each of second chamfers **121c**, **121d** is inclined relative to main surface **121a** so as to increase the thickness of cutting edge member **20b** as each of second chamfers **121c**, **121d** is closer to main surface **121a**. Accordingly, when flank face **22** is ground in order to remove each of damage portions **40**, **140**, the thickness of cutting edge member **20b** at the first ridgeline (**124**) serving as cutting edge **124** is increased.

The following describes functions and effects of throwaway insert **2** of the present embodiment. In addition to the effects of throwaway insert **1** of the first embodiment, throwaway insert **2** of the present embodiment exhibits the following effects.

In throwaway insert **2** of the present embodiment, rake face **121** further includes each of second chamfers **121c**, **121d** connected to main surface **121a**, first chamfer **121b**, and flank face **22**. Each of second chamfers **121c**, **121d** is inclined relative to main surface **121a** so as to increase the thickness of cutting edge member **20b** as each of second chamfers **121c**, **121d** is closer to main surface **121a**. Cutting

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edge **124** includes second cutting edge parts **124e**, **124f** constituted of the second ridgeline parts (**124e**, **124f**) formed by second chamfers **121c**, **121d** and flank face **22**. In the plan view from upper surface **11** of base **10**, first distance d_1 between extreme tip portion **30** of cutting edge member **20b** and base **10** is larger than second distance d_2 between each of second cutting edge parts **124e**, **124f** and base **10**.

In throwaway insert **2** of the present embodiment, rake face **121** further includes second chamfers **121c**, **121d**. Accordingly, when cutting edge member **20b** is ground and when a workpiece is cut using throwaway insert **2**, damage portions **40**, **140** can be suppressed from being produced in cutting edge **124**. Throwaway insert **2** of the present embodiment has more stable quality.

In throwaway insert **2** of the present embodiment, in the plan view from upper surface **11** of base **10**, flank face **22**, first connecting face **23**, and second connecting face **26** are located external to base **10**. Therefore, when damage portions **40**, **140** are produced in cutting edge **124** while cutting a workpiece using throwaway insert **2**, damage portions **40**, **140** can be removed by grinding flank face **22** of cutting edge member **20b**.

Generally, widths w_1 , w_2 of damage portions **40**, **140** in the direction parallel to main surface **121a** of rake face **121** are smaller than heights h_1 , h_2 of damage portions **40**, **140** in the direction perpendicular to main surface **121a** of rake face **121**. In throwaway insert **2** of the present embodiment, the grinding of cutting edge member **20b** to remove damage portions **40**, **140** in cutting edge member **20b** can be performed a larger number of times. According to throwaway insert **2** of the present embodiment, the number of times of reusing cutting edge member **20b** can be increased, whereby throwaway insert **2** of the present embodiment can be used economically.

In throwaway insert **2** of the present embodiment, each of second chamfers **121c**, **121d** is inclined relative to main surface **121a** so as to increase the thickness of cutting edge member **20b** as each of second chamfers **121c**, **121d** is closer to main surface **121a**. Accordingly, when flank face **22** is ground in order to remove damage portions **40**, **140**, the thickness of cutting edge member **20b** at the first ridgeline (**124**) serving as cutting edge **124** is increased, whereby damage portions **40**, **140** are less likely to be produced in cutting edge **124**. Throwaway insert **2** of the present embodiment has stable quality.

In throwaway insert **2** of the present embodiment, cutting edge member **20b** including first chamfer **121b** and second chamfers **121c**, **121d** can be ground only by grinding flank face **22** to remove damage portions **40**, **140**. On the other hand, in a throwaway insert of a third comparative example, cutting edge member **20b** including first chamfer **21b** and second chamfers **121c**, **121d** can be ground by grinding rake face **121** to remove damage portions **40**, **140**, then grinding a portion of rake face **121** to form second chamfers **121c**, **121d**, and further grinding a portion of rake face **121** to form first chamfer **121b**. According to throwaway insert **2** of the present embodiment, cutting edge member **20b** including first chamfer **21b** and second chamfers **121c**, **121d** can be ground with a smaller number of grinding steps.

Extreme tip portion **30** of cutting edge member **20b** is a portion used most to cut a workpiece, and is a portion at which damage portion **40** is most likely to be produced. Since first distance d_1 is larger than second distance d_2 in the plan view from upper surface **11** of base **10**, the number of times of reusing cutting edge member **20b** can be increased. Throwaway insert **2** of the present embodiment can be used economically.

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In throwaway insert **2** of the present embodiment, first angle θ_1 between first chamfer **121b** and first extension plane **121e** of main surface **121a** is smaller than second angle θ_2 between each of second chamfers **121c**, **121d** and first extension plane **121e** of main surface **121a**. Therefore, in the plan view from upper surface **11** of base **10**, first distance d_1 is larger than second distance d_2 . According to throwaway insert **2** of the present embodiment, the number of times of reusing cutting edge member **20b** can be increased, whereby throwaway insert **2** of the present embodiment can be used economically.

Third Embodiment

With reference to FIG. **14** to FIG. **17**, the following describes a throwaway insert **3** of a third embodiment. Throwaway insert **3** of the present embodiment includes the same configuration as that of throwaway insert **1** of the first embodiment, but is different therefrom in respective configurations of a cutting edge member **20c**, a backing body **18c**, and a base **10c**.

As shown in FIG. **17**, in throwaway insert **3** of the present embodiment, in the plan view from main surface **21a**, a flank face **22c** is inclined relative to main surface **21a** so as to be closer to the two side surfaces (**13a**, **13b**) of base **10c** as flank face **22c** is further away from main surface **21a**. In the plan view from main surface **21a**, a fourth ridgeline **29** is located at the two-side-surface (**13a**, **13b**) side relative to cutting edge **24**. Fourth ridgeline **29** is formed by flank face **22c** and a bottom surface **28** of cutting edge member **20c** opposite to rake face **21**.

As shown in FIG. **16**, in a cross section (cross section shown in FIG. **16**) that is orthogonal to main surface **21a** and that is orthogonal to the first ridgeline (**24**) in the plan view from main surface **21a**, flank face **22c** is inclined relative to main surface **21a** so as to be closer to the two side surfaces (**13a**, **13b**) of base **10c** as flank face **22c** is further away from main surface **21a**. As shown in FIG. **16** and FIG. **17**, flank face **22c** is inclined relative to main surface **21a** such that cutting edge member **20c** gradually become thinner in a direction from rake face **21** toward bottom surface **28**.

Flank face **22c** may be inclined at an inclination angle θ_5 of more than or equal to 0.1° and less than or equal to 15° relative to an imaginary plane **21v** that is orthogonal to main surface **21a** and that is in contact with the first ridgeline (**24**). Imaginary plane **21v** is a plane parallel to flank face **22** of the first embodiment. In the cross section (cross section shown in FIG. **16**) that is orthogonal to main surface **21a** and that is orthogonal to the first ridgeline (**24**) in the plan view from main surface **21a**, flank face **22c** may be inclined at inclination angle θ_5 of more than or equal to 0.1° and less than or equal to 15° relative to the normal line (**21v**) of main surface **21a** so as to be closer to the two side surfaces (**13a**, **13b**) of base **10c** as flank face **22c** is further away from main surface **21a**.

In the plan view from main surface **21a**, a side surface **18s** of backing body **18c** may be inclined in the same manner as flank face **22c**. Side surface **18s** of backing body **18c** may be flush with flank face **22c** of cutting edge member **20c**. As one modification of the present embodiment, side surface **18s** of backing body **18c** may be flush with the two side surfaces (**13a**, **13b**) of base **10c**, and flank face **22c** of cutting edge member **20c** may protrude relative to the two side surfaces (**13a**, **13b**) of base **10c** and side surface **18s** of backing body **18c**.

In throwaway insert **3** of the present embodiment, base **10c** has a rhombus shape in the plan view from upper surface

11 of base 10c. The plurality of side surfaces 13 may include side surface 13a, side surface 13b, side surface 13c, and a side surface 13d.

As shown in FIG. 17, in the plan view from upper surface 11, each of side surfaces 13a, 13b, 13c, 13d of base 10c is inclined relative to lower surface 12 so as to be further away from cutting edge 24 as each of side surfaces 13a, 13b, 13c, 13d of base 10c is further away from upper surface 11. As shown in FIG. 16 and FIG. 17, each of side surfaces 13a, 13b, 13c, 13d of base 10c is inclined relative to lower surface 12 such that base 10c becomes gradually thinner in a direction from upper surface 11 toward lower surface 12. Accordingly, side surfaces 13a, 13b, 13c, 13d of base 10c can be suppressed from being worn during cutting.

Each of side surfaces 13a, 13b, 13c, 13d of base 10c may be inclined at an inclination angle θ_6 (degree) relative to lower surface 12 in the cross section (cross section shown in FIG. 16) orthogonal to each of side surfaces 13a, 13b, 13c, 13d and lower surface 12. Regarding inclination angle θ_5 (degree) and inclination angle θ_6 (degree), θ_6-90 may be equal to θ_5 or may be larger than θ_5 .

The following describes functions and effects of throwaway insert 3 of the present embodiment. In addition to the effects of throwaway insert 1 of the first embodiment, throwaway insert 3 of the present embodiment exhibits the following effects.

In throwaway insert 3 of the present embodiment, flank face 22c is inclined relative to main surface 21a so as to be closer to the two side surfaces (13a, 13b) of base 10c as flank face 22c is further away from main surface 21a in the plan view from main surface 21a. Since flank face 22c is inclined in this way, a flank amount of flank face 22c relative to a workpiece can be increased. Flank face 22c is suppressed from being worn during cutting, whereby throwaway insert 3 has a longer life.

Further, since flank face 22c is inclined in this way, cuttability of cutting edge 24 is improved. Even though cutting edge member 20c protrudes relative to the two side surfaces (13a, 13b) of base 10c, occurrence of chatter vibration can be suppressed during cutting of a workpiece, thereby suppressing decrease of cutting precision.

In throwaway insert 3 of the present embodiment, flank face 22c is inclined at inclination angle θ_5 of more than or equal to 0.1° and less than or equal to 15° relative to imaginary plane 21v that is orthogonal to main surface 21a and that is in contact with the first ridgeline (24). By setting inclination angle θ_5 of flank face 22c to be more than or equal to 0.1° , wear of flank face 22c and occurrence of chatter vibration during cutting can be further suppressed. By setting inclination angle θ_5 of flank face 22c to be less than or equal to 15° , flank face 22c can be ground using a grindstone without an interference of the grindstone with base 10c.

Fourth Embodiment

With reference to FIG. 18 to FIG. 22, the following describes a throwaway insert 4 of a fourth embodiment. Throwaway insert 4 of the present embodiment includes the same configuration as that of throwaway insert 2 of the second embodiment, but is different therefrom in respective configurations of a cutting edge member 20d, backing body 18c, and base 10c.

Flank face 22c of cutting edge member 20d of the present embodiment is inclined in the same manner as flank face 22c of cutting edge member 20c of the third embodiment. Specifically, as shown in FIG. 22, flank face 22c is inclined

relative to main surface 121a so as to be closer to the two side surfaces (13a, 13b) of base 10c as flank face 22c is further away from main surface 121a in the plan view from main surface 121a. In the plan view from main surface 121a, fourth ridgeline 29 is located at the two-side-surface (13a, 13b) side relative to cutting edge 124. Fourth ridgeline 29 is formed by flank face 22c and a bottom surface 28 of cutting edge member 20d opposite to rake face 121.

As shown in FIG. 20 and FIG. 21, in a cross section (each of a cross section shown in FIG. 20 and a cross section shown in FIG. 21) that is orthogonal to main surface 121a and that is orthogonal to the first ridgeline (124) in the plan view from main surface 121a, flank face 22c is inclined relative to main surface 121a so as to be closer to the two side surfaces (13a, 13b) of base 10c as flank face 22c is further away from main surface 121a. As shown in FIG. 20 to FIG. 22, flank face 22c is inclined relative to main surface 121a such that cutting edge member 20d gradually becomes thinner in a direction from rake face 121 toward bottom surface 28.

Flank face 22c may be inclined at an inclination angle θ_5 of more than or equal to 0.1° and less than or equal to 15° relative to an imaginary plane 121v that is orthogonal to main surface 121a and that is in contact with the first ridgeline (124). Imaginary plane 121v is a plane parallel to flank face 22 of the second embodiment. In the cross section (each of the cross section shown in FIG. 20 and the cross section shown in FIG. 21) that is orthogonal to main surface 121a and that is orthogonal to the first ridgeline (124) in the plan view from main surface 121a, flank face 22c may be inclined at inclination angle θ_5 of more than or equal to 0.1° and less than or equal to 15° relative to the normal line (121v) of main surface 121a so as to be closer to the two side surfaces (13a, 13b) of base 10c as flank face 22c is further away from main surface 121a.

Side surface 18s of backing body 18c of the present embodiment is inclined in the same manner as side surface 18s of backing body 18c of the third embodiment. Base 10c of the present embodiment includes the same structure as that of base 10c of the third embodiment.

Throwaway insert 4 of the present embodiment exhibits the effect of throwaway insert 2 of the second embodiment and the effect of throwaway insert 3 of the third embodiment.

The embodiments disclosed herein are illustrative and non-restrictive in any respect. The scope of the present invention is defined by the terms of the claims, rather than the embodiments described above, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

REFERENCE SIGNS LIST

- 1, 2, 3, 4: throwaway insert; 10, 10c: base; 11: upper surface; 11e: second extension plane; 12: lower surface; 12v: normal line; 13: plurality of side surfaces; 13a, 13b, 13c, 13d, 18s: side surface; 14: recess; 15a: first base ridgeline; 15b: second base ridgeline; 16: hole; 18, 18c: backing body; 20, 20b, 20c, 20d: cutting edge member; 21, 121: rake face; 21a, 121a: main surface; 21b, 121b: first chamfer; 21e, 121e: first extension plane; 21v: imaginary plane; 22, 22c: flank face; 23: first connecting face; 24, 124: cutting edge; 24a, 124a: first straight cutting edge portion; 24b, 124b: curved cutting edge portion; 24c, 124b, 124c: second straight cutting edge portion; 24d, 124d: first cutting edge part; 24e: third straight cutting edge portion; 24f: fourth

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straight cutting edge portion; **25, 125**: second ridgeline; **26**: second connecting face; **27, 127**: third ridgeline; **28**: bottom surface; **29**: fourth ridgeline; **30**: extreme tip portion; **40, 140**: damage portion; **41, 42, 43, 44, 45, 141, 142, 143, 144, 145**: grinding line; **121c, 121d**: second chamfer; **124e, 124f**: second cutting edge part.

The invention claimed is:

1. A throwaway insert comprising:

a base having an upper surface, a lower surface, and a plurality of side surfaces that connect the upper surface to the lower surface, the base being provided with a recess at a corner portion at which the upper surface crosses two side surfaces of the plurality of side surfaces; and

a cutting edge member joined to the recess, wherein the cutting edge member includes

a rake face,

a flank face extending to cross the rake face,

a first connecting face connecting the flank face to one side surface of the two side surfaces and extending to cross the rake face,

a second connecting face connecting the flank face to the other side surface of the two side surfaces and extending to cross the rake face, and

a first ridgeline formed by the rake face and the flank face and serving as a cutting edge,

the rake face includes

a main surface extending along the upper surface, and a first chamfer provided at an edge tip portion of the cutting edge member, the edge tip portion including

an extreme tip portion of the cutting edge member, the cutting edge includes a first cutting edge part constituted of a first ridgeline part formed by the first chamfer and the flank face,

in a plan view from the upper surface of the base, the flank face, the first connecting face, and the second connecting face are located external to the base,

the first chamfer is inclined relative to the main surface so as to increase a thickness of the cutting edge member as the first chamfer is closer to the main surface,

a second ridgeline formed by the rake face and the first connecting face crosses the first ridgeline at an obtuse angle, and

a third ridgeline formed by the rake face and the second connecting face crosses the first ridgeline at an obtuse angle.

2. The throwaway insert according to claim **1**, wherein the rake face further includes a second chamfer connected to the main surface, the first chamfer, and the flank face, the second chamfer is inclined relative to the main surface so as to increase the thickness of the cutting edge member as the second chamfer is closer to the main surface,

the cutting edge includes a second cutting edge part constituted of a second ridgeline part formed by the second chamfer and the flank face, and

in the plan view from the upper surface of the base, a first distance between the extreme tip portion of the cutting edge member and the base is larger than a second distance between the second cutting edge part and the base.

3. The throwaway insert according to claim **2**, wherein a first angle between the first chamfer and a first extension plane of the main surface is smaller than a second angle between the second chamfer and the first extension plane of the main surface.

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4. The throwaway insert according to claim **1**, wherein a first angle between the first chamfer and a first extension plane of the main surface is more than or equal to 3° and less than or equal to 25° .

5. The throwaway insert according to claim **1**, wherein the extreme tip portion of the cutting edge member is located on a second extension plane of the upper surface.

6. The throwaway insert according to claim **1**, wherein in the plan view from the main surface, the flank face is inclined relative to the main surface so as to be closer to the two side surfaces of the base as the flank face is further away from the main surface.

7. The throwaway insert according to claim **6**, wherein the flank face is inclined at an inclination angle of more than or equal to 0.1° and less than or equal to 15° relative to an imaginary plane that is orthogonal to the main surface and that is in contact with the first ridgeline.

8. The throwaway insert according to claim **1**, wherein the cutting edge includes

a first straight cutting edge portion located between the first connecting face and the first cutting edge part, and a second straight cutting edge portion located between the second connecting face and the first cutting edge part, and

when γ (degree) represents an angle between the first straight cutting edge portion and the second straight cutting edge portion in the plan view from the upper surface of the base, each of a first crossing angle α (degree) between the first ridgeline and the second ridgeline and a second crossing angle δ (degree) between the first ridgeline and the third ridgeline is more than or equal to $(160-\gamma/2)$ and less than or equal to $(200-\gamma/2)$.

9. The throwaway insert according to claim **1**, wherein the cutting edge includes

a first straight cutting edge portion located between the first connecting face and the first cutting edge part, and

a second straight cutting edge portion located between the second connecting face and the first cutting edge part,

the first straight cutting edge portion is parallel to a first base ridgeline formed by the upper surface and the one side surface of the base, and

the second straight cutting edge portion is parallel to a second base ridgeline formed by the upper surface and the other side surface of the base.

10. The throwaway insert according to claim **9**, wherein in the plan view from the upper surface of the base, a third distance between the first straight cutting edge portion and the first base ridgeline is more than or equal to 0.01 mm and less than or equal to 1 mm, and

in the plan view from the upper surface of the base, a fourth distance between the second straight cutting edge portion and the second base ridgeline is more than or equal to 0.01 mm and less than or equal to 1 mm.

11. The throwaway insert according to claim **1**, wherein the first cutting edge part includes a curved cutting edge portion having a protruding curved shape, and the curved cutting edge portion includes the extreme tip portion.

12. The throwaway insert according to claim **1**, wherein the cutting edge member includes one of the following materials: diamond, cubic boron nitride, cemented carbide and cermet.